The Meteorological Magazine

December 1993

1864 Last Issue 1993

Some highlights from early editions

Full contents on back cover

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The

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The last editorial

One of the joys of editing *The Meteorological Magazine* has been that it has no tradition of printing Editorials. These slots are a trap for the unwary and provide a superb location for putting one's foot in one's mouth in public, making prophecies that fail spectacularly, and generally making a fool of oneself. Myself, I have from time to time taken the opportunity to add italicized comment, as with our very last item in this issue.

A quick check recently suggested that as many as one third of our articles have been from outside the UK in recent years. This issue contained none until a letter to Hong Kong brought forth the kind of reply (on the back pages) of which editors dream. There is one other foreign item that might escape your attention; this is on the back outside cover. My friends in Météo-France printed what amounts to an obituary in *La Météorologie* for which I thank them publicly here. We had intended to collaborate with Deutsche Wetterdienst to ensure that interesting articles appeared in three of the main European languages for the benefit of readers who would otherwise have had to make their own translations. I can only hope that the infant *Meteorological Applications* takes up the idea.

A final editorial must also pay thanks to three teams of unsung heroes, well known to authors but perhaps not to readers. The sub-editors go through the final text and catch all the howlers that the editor and author have missed. They also remove the blemishes that would cumulatively irritate the reader and give the magazine a second-rate appearance. The second team is our Graphics Studio who have seen to it that the quality of illustrations and diagrams have been to the highest standards and rarely bettered by contemporary journals. Last, but by no means least is Her/His Majesty's Stationery Office who have organized the publication of the Magazine since taking over from Edward Stanford in 1920; we are grateful to them for granting us 40 pages for this issue *at no extra cost to the subscriber.*

I should like to remind readers that many of the the techniques that are described in the *Forecasters' reference book* appeared first as papers in this magazine. Almost all these papers would require at least four or fives pages here, plus diagrams and, often mathematics; to have selected just one would have been invidious and take up the space of two or three shorter items, so all have been omitted.

Since 1864 many fascinating, enlightening and instructive papers have appeared in our pages. What follows are just a few highlights, in chronological order; I regret the omission of those for which there is no room despite the extra pages. My choice of topics is, I hope catholic, but it is biased towards brevity and accessibility and away from complicated typesetting and figures. A few special pages are facsimiles of the originals, most have been reset. No changes have been made to punctuation or usage of English; nevertheless the Victorians seem to have had a penchant for very small type which may have led to a few trivial errors during enlargement and conversion to the typeface you see here.

Finally, a warning. If you would like to read some of the old back numbers please allow plenty of time. They are a trap for the unwary, full of fascinating insights and the intended ten-minute browse will miraculously take half a day!

Farewell,

R.M. Blackall

SYMONS'S RAINFALL CIRCULAR.

JANUARY, 1864.

	STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	Height of Gauge. Above Ground.		Above Sea Level.	Depth of Rain. Total in the Month.	Greatest Fall in 24 hours. Depth.	Date.	Days on which Rain, Snow, or Hail was measured.
		ft.	in.	feet.	inches.	inches.		
ENGLAND AND WALES.	I. Camden Town, London	0	4	100	1·07	·32	20	9
	II. Linton Park, Staplehurst	0	6	200 ?	·77	·14	24	15
	II. Selborne, Hants	4	0	500 ?	1·97	·39	19	15
	III. Banbury	7	0	345	·94	·30	24	17
	III. Wisbech	0	6	10	·73	·32	18	12
	IV. Culford, Bury St. Edmunds	1	2	...	·83	·32	17	6
	V. Calne, Wiltshire	0	11	321	1·66	·27	1	18
	V. Goodamoor, near Plymouth	0	2	580	4·24	1·10	19	16
	V. Taunton, Somerset	1	6	38	1·65	·64	1	15
	VI. Orleton, Worcester	0	9	200	1·31	·22	23	16
	VII. Wigston, Leicester	0	6	220	·88	·22	23	12
	VII. West Retford	0	6	50	·87	·21	18	13
	VII. Derby	5	0	180	1·08	·20	17	15
	VIII. Manchester	3	0	106	1·72	·55	20	13
	IX. York	0	6	50	·82	·30	21	13
	IX. Arncliffe, Yorks	3	0	750	4·18	·85	19	13
	X. North Shields	1	0	124	1·00	·48	20	14
	X. Seathwaite, Cumberland	1	0	422	13·23	2·34	22	13
	XI. Haverfordwest	2	0	60	5·12	1·44	15	15
	XI. Cefnfaes, Rhayader	2	0	880	2·70	...	...	16
SCOTLAND.	XII. Dumfries	0	5	70	2·60	·50	12	16
	XIV. Auchendrane House, Ayr	2	3	94	2·40	·57	22	15
	XV. Oban, Argyll	0	4	10	5·80	·85	12	16
	XVI. Nookton, Leven, Fife	0	6	80	1·86	·67	15	15
	XVI. Deanston, Perth	0	0	60	4·45	1·25	31	11
	XVII. Aberdeen	0	7	55	1·44	·32	23	19
	XVIII. Culloden, Inverness	3	0	104	·45	...	...	7
	XVIII. Portree, Isle of Skye	0	4	60	11·38	1·66	26	22
	XIX. Scourie, Sutherland	0	3	26	2·80	...	...	10
	XIX. Sandwick, Orkney	2	0	78	1·37	·42	27	15
IRELAND.	XX. Cork	5	0	50	4·07	1·55	31	14
	XX. Waterford	4	0	60	3·75	1·00	11	18
	XX. Killaloe, Clare	0	5	123	2·95	·52	9	18
	XXI. Portarlington	9	0	236	3·97	·73	1	26
	XXI. Monkstown, Dublin	0	6	90	3·21	1·23	1	16
	XXII. Galway	6	0	25	4·62	·62	23	22
	XXII. Bunninadden, Sligo	1	3	...	3·04	·39	17	18
	XXIII. Owendoon, Bawnboy	...		...	2·63	·41	23	19
	XXIII. Waringstown, Down	0	4	191	1·65	·33	12	12
	XXIII. Leckpatrick, Strabane	0	5	260	2·21	·36	10	17

REMARKS.

ENGLAND AND WALES.

Camden Town.—Sharp frost until 10th. Min. 15°·1 (on grass 8°·6) on 6th.
Linton Park.—Sharp frost, and very dry the first 10 days, afterwards mild. No snow.
Selborne.—Min. temperature 9°·5 on 7th. Pale aurora on 9th, 23rd, and 27th.
Banbury.—Lowest temperature 10°. Much fog.
Wisbech.—For 23 days the barometer was above 30 inches. Min. 15°·1; (on grass 11°·8) on 6th. Slight snow on 3rd.
Culford.—Very slight snow on 2nd. Min. temp. 9° on 6th.
Calne.—Snow on 3rd. Snowdrops in bloom on 8th; crocuses on 15th. Dense fog from 13th to 16th, and again on 18th. A fine month.
Goodamoor.—Sharp frost from 3rd to 9th; on morning of 5th the min. temp. was 10°, and on the grass 8°.
Taunton.—Cold set in on 3rd, and on the 4th, 5th, and 6th the temp. fell to 13°.
Orleton.—Severe frost till 10th; rivers all frozen. Min. 10°, and on grass 6°·8, on 7th. Dense fog from 12th to 19th. On 22nd and 23rd violent winds in the morning.
Wigston.—Rainfall below the average, and much fog. Severely cold weather from 5th to 8th.
West Retford.—Min. 10° on 7th; frost on 22 nights.
Derby.—Rainfall 1·20 in. below the rainfall of 14 years.
Manchester.—January has been remarkable for the cold week ending Jan. 9th—the mean temp. of which was 12°·2 below mean of 15 years; but the ground has never once been covered with snow. Rainfall 0·75 in. below average of 70 years.
Arncliffe.—Min. 16°. No snow.
North Shields.—Fog prevalent from 5th to 20th; snow on 6 days; lunar halos on 19th & 21st.
Seathwaite.—No rain till 11th; 1·53 on 12th; 1·28 on 23rd; 1·73 on 27th; 1·03 on 28th; and 1·59 on 31st.
Haverfordwest.—Intensely cold during first 8 days. Min. 10° on night of 5th. Slight snow on 1st. Last three weeks stormy, with heavy floods.
Cefnfaes.—Min. 14° on 7th.

SCOTLAND.

Dumfries.—Frosty until 11th; min. 17° on 6th; snow on 21st and 23rd, but a mild month on the whole.
Auchendrane.—Rainfall 2·30 in. below the average of 8 years. Hard frost the first 11 days, but the rest of the month mild and stormy.
Oban.—First 10 days fine and frosty; min. 14° on 6th; remainder of month mild and wet.
Nookton.—A fine January; very cold, with severe frost (min. 11° on 8th) from 2nd to 9th; no snow or hail except on 31st.
Deanston.—Min. 12° on 6th; no snow on the low grounds, except a slight shower on 31st.
Aberdeen.—Barometer very high at commencement of month; min. temp. 22°·8 on 8th.
Culloden.—Fair until 21st, with sharp frost the first 10 days; min. 22°·2 on 6th.
Portree.—No rain the first nine days; upwards of an inch on 21st, 29th, and 30th. Thunderstorm on 19th. Lunar halos on 19th and 21st.
Scourie.—Clear and frosty until 9th. Hail on 31st.
Sandwick.—The driest January during the whole period of observation (23 years), the average being 4·17 in. Aurora on six nights; large halo on 3rd. January has been as pleasant a month as December was the reverse.

IRELAND.

Killaloe.—Some fine bright days, but on the whole a dark, damp, cheerless month.
Monkstown.—Severe frost from 5th to 8th; min. temp. 20°·5 on 7th. Lunar halo on 19th. Latter part of month mild and stormy.
Waringstown.—A remarkably fine month, and mild, except during the first week, when the temperature fell to 17°.
Leckpatrick.—No rain till 9th. Min. 24° (on grass 19°) on 6th. Southerly winds throughout the month.

NOTE.—Frost very general during the first ten days—most severe in the midland and eastern counties of England. Rainfall not much exceeding half the average.

G. J. SYMONS.

Camden Road Villas, February, 1864.

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INDEX.

SYMONS'S
MONTHLY
METEOROLOGICAL MAGAZINE.

I.] FEBRUARY, 1866. [PRICE FOURPENCE, or 5s. per ann. post free

INTRODUCTORY.

I BELIEVE that it is a rule *not* to judge of a serial by its first number, and I hope that the rule will be adhered to in the present instance, since future numbers will, at any rate, receive more time and attention than the present one, which having to appear simultaneously with *British Rainfall*, 1865, has had to be cared for in scraps of time snatched from its more bulky *confrère*. But let not this semi-apology be construed as a promise of future brilliancy, on the contrary, I would now, as ever, rather promise nothing, and let all I do sink or swim by its own merits; still it may be well to state that I *hope* to give in future numbers, Tables of Foreign and Colonial Rainfall, Notes on Thunderstorms in England during 1856-7 and 8, also on those in 1864 (these are somewhat voluminous, and contain not only curious results as to colour, &c., of lightning, but also as to its mechanical effects); Notices of Meteorological Books, new and old; and, above all, the latest rainfall intelligence, both as to its fall, its measurement, its publications, and its instruments. Lastly, I need hardly say, that its future depends very much on its readers; if they will send me prompt and full information of any unusual occurrence in their neighbourhood, and if they will (if they think it good) recommend it to their friends, the two essentials of high quality and a paying circulation may be obtained; and so I may be able to enlarge it, though my maxim always is, say everything in as few words as possible.

G. J. SYMONS.

136, Camden Road, N.W., Feb. 7th, 1866.

ON THE STORAGE OF WATER FOR COUNTRY VILLAGES.

THE severity of the drought during the last two or three summers has helped to force public attention to a point not generally appreciated at its full import. I refer to the influence of drainage operations on the supply of water available for man and beast in the summer months and periods of drought. It is very desirable the

August 1866

A NEW ENEMY TO RAIN GAUGES.

My dear Sir,—I have just encountered a new enemy to rain gauges, which had I not discovered it in time, or had I not kept several gauges of different sizes, heights, &c., might have caused me considerable annoyance. On looking into the receiver of my Apps' gauge (5 in.), I detected a small leaf, and, supposing it to have been blown in by the wind, proceeded to remove it, when I saw several more equally small, and some fragments. On carefully examining these leaves and fragments, I discovered that the pipe of the receiver of the gauge was completely filled up with nine nests of one of the genus Megachile, or leaf-cutter bee. I had great difficulty in removing them, so beautifully were they fitted and soldered as it were to the tube. To prevent the recurrence of this, I have fastened a little cap over the aperture of the pipe, leaving just sufficient space to allow the rain to trickle through freely, but small enough to exclude a similar invader on any future occasion. Thinking you might like to notice this in the next number of your *Meteorological Magazine*, I send you this account. Yours always, very truly,

Strathfield Turgiss Rectory, July 20th. C. H. GRIFFITH.

THE TRUE HISTORY OF A THUNDERBOLT.

On July 2nd one of the London daily papers startled some of its readers by inserting a letter on the thunderstorm of June 30th, in which the writer said, " At six o'clock it broke out again with increased violence, the rain descending in torrents, and at a few minutes past seven a thunderbolt fell in the gutter opposite my house (in Westbourne Park, Notting Hill,) and was smashed to pieces, one of which I have at the hour at which I write. Numbers of persons are still searching for the fragments."

Feeling certain that there was a weak point somewhere, inasmuch as " thunderbolts" have no existence, we called on the writer of the letter and other residents, found the story amply confirmed, received several pieces of the "thunderbolt" (by the bye, some were sold at 10/- and 15/- each), and eventually ascertained that one of the pupils of an analytical chemist had availed himself of his tutor's absence to fill a capsule with materials calculated to burn vigorously, and explode in heavy rain, and, during the height of the storm, had thrown the burning mass into the gutter, so making an artificial thunderbolt. It is no wonder that the neighbours were taken in by a trick so well-arranged.

September 1866

THE METEOROLOGICAL DEPARTMENT OF THE BOARD OF TRADE

THE appointment of chief of the above office could scarcely be a sinecure in a country like this, where ceaseless alternations require attention, and where so many fancy they possess the key of nature's secrets, and can tell whence the wind cometh and whither it goeth. Admiral FitzRoy, however, took such unusual steps to bring his work before the public that it is no wonder that during the ten years in which he presided over the Department constant criticism was his lot; and that with his total lack of management, all his energy, experience, self-devotion, and zeal, were inadequate to cope with the pressure of work necessarily incidental to the position he held. However, the good old Admiral is gone, and we can only repeat the sentiment of one of the leading journals "He is gone to his rest, and many a storm-sheltered mariner will look to the signal drum, and grieve with a manly sorrow for the loss of Robert FitzRoy."

Shortly after his death, a letter was addressed by the Board of Trade to the President of the Royal Society asking the advice of the Royal Society — (1) As to the extent to which the Department had fulfilled the objects for which it was organized; (2) As to the reliability of forecasts and storm signals; (3) As to the future conduct of the Department. About a month afterwards (June 15th, 1865), General Sabine, on behalf of the Royal Society, replied — that they considered the evidence submitted to them justified their recommending that the forecasting should remain in the hands of Mr. Babington, by whom it had been virtually carried on for some months past; that the meteorological observations made at sea by the captains of the royal and merchant navies be transferred to the custody of the Hydrographer, with a view to the introduction of the results into the Admiralty Charts; and lastly, that an entirely new system be organized for observing the "Land Meteorology of the British Islands," the stations being not less than six* in number, and provided with self-recording apparatus, the records from which should be sent weekly or otherwise to Kew Observatory, which is hereby proposed as the centre of

*Falmouth, Kew, Stonyhurst, Armagh, Glasgow, and Aberdeen, are proposed.

this system. The Board of Trade subsequently expressed a desire for more thorough consideration of the progress made in marine meteorology, suggested the appointment of a small committee of investigation, and intimated that they saw some difficulty in the proposed maintenance of two establishments, one at Whitehall and one at Kew. Eventually, the following three gentlemen were appointed (in November, 1865) a committee of investigation:–

Royal Society — Francis GALTON, Esq., F.R.S., General Secretary of the British Association.
Admiralty — STAFF-COMMANDER EVANS, R.N., F.R.S., Chief Naval Assistant to the Hydrographer.
Board of Trade — T.H. FARRER, Esq., one of the Secretaries to the Board of Trade.

Their report was presented to Parliament last session, and proves three points at once — first, the desirability of such a thorough investigation, the efficacy of the committee proposed by the Board of Trade, and the ability (if that wanted proving) of the persons nominated. It is rather voluminous (81 pages folio), and so replete with facts and details of importance as to render it extremely difficult to present an abridgment doing it full justice. After giving a clear and succinct account of the origin and original functions of the Department, it notices the steps taken to obtain meteorological observations at sea, and their results; also the method adopted by the Department in extracting observations, which comes in for detailed criticism of an exhaustive character, and a plan for future use is suggested of considerable value, and which we will therefore examine rather fully. Of course the essential difference between the meteorological register of a ship, and an observatory, is that the place of observation is movable in one case and fixed in the other. This difficulty is obviated by portioning out the ocean into squares embracing 10° of latitude and 10° of longitude — of course, therefore, of variable real area, but still readily recognized divisions. The old plan was to have "Data Books" for each subject, paged to correspond with the squares just referred to; then if the Department were working up any subject, the ships' registers were searched for that one detail only, and the rest was left uncopied; thus at least eight or ten separate searches were made, involving quite fourfold the trouble of the plan now proposed, which is, that each register should be copied out at once on to a set of printed cards, which could then be searched, sub-divided to any extent, and available in any way. We have seldom seen a more sensible or useful suggestion. The Committee proceed to enumerate and comment on the publications of the Department, which as a rule are condemned for their want of method. Among their suggestions for future practice is that of a form (Appendix p. xviii.) in which certain observations might be tabulated for publication, which is either an absurdly complicated misprint, or it requires explanation. The year is divided into four quarters, as follows: — December, January, February; (2) March, April, June; (3) July, August, September; (4) August, November, December. May and October are therefore omitted, and August and December mentioned twice. We cannot comprehend this at all.

We have already remarked that the Board of Trade suggested a possible difficulty by the maintenance of a duplicate establishment at Kew; a paragraph, however, on p.17 of the report under notice shows a third branch of the Meteorological Department: — "The Admiralty Hydrographic Department are now devoting considerable pains to the preparation of physical charts — such as Ice, General Ocean Currents, and Wind Charts. In these it is proposed to embody the results collected by the Meteorological Department in a form available to seamen."

The second part of the report is occupied by an account of the origin, and a rigorous examination of the Forecasts and Storm Warnings issued by the Department; it is far too voluminous for extract, but the following are the conclusions arrived at by the Committee:–

"(1) That the maxims on which the Department act in foretelling weather have not been reduced into any clear or systematic form, and are not shown to have been established by sufficient induction from observed fact.

"(2) That as matter of fact the Daily Forecasts are not shown to be correct, and that they are not in our opinion useful.

"(3) That the Storm Warnings, so far as they indicate the force of coming gales, have been sufficiently correct to be of some use, and that their utility is widely admitted. Also, that they have improved, and that they are probably capable of still greater improvement.

"(4) That the Storm Warnings, so far as they indicate the direction as well as force of coming gales, are not shown to have been so far precise or correct as to be of use."

After mentioning the benefit conferred by the erection by the Department of 95 good barometers at some of the poorest of the fishing villages, the report notices and approves the suggestion of the Royal Society as to the establishment of the six stations with self-recording, instruments already referred to, proposes that they be supplemented by about sixty secondary stations, lighthouses, &c., and that the returns thus obtained should be laid down on maps similar to those of M. Le Verrier, and published at a low price. They insist on the officer issuing a storm signal "noting down at the time, and reducing into exact shape afterwards, the maxims or principles which have guided him in making the Signal of Force, or Prediction of Direction; the facts to which those maxims are applied; the mode in which he has applied or combined them, the value he has attached to each of them, and the value of the probability he has thus obtained, and which is indicated by the signal or prediction"; they also propose that a rigorous check on the signals be kept by collating all available records with the predictions.

They further propose that the collection of ocean statistics should continue much as it was originally arranged by Admiral FitzRoy, but that the discussion of the results should be on the improved plan already explained; that additional buildings be erected at Kew, and the branch department there should be under the control of a scientific body receiving a grant of about £7000 per annum from Government, and out of it defraying all expenses incidental to the thorough and systematic collection of weather statistics of the British Isles, and the maintenance of the system of storm warnings. As far as we can see, the estimated expense of the Kew and Board of Trade Meteorological Departments would be about £15,000 per annum, to which must be added the expenses incurred at the Hydrographic Department in getting out and publishing charts. The report goes on to express the hope that at no distant day one international centre may be established, and thus all divided and therefore duplicate labour be avoided; and concludes with the following paragraph:–

"We feel, moreover, that we should be doing great injustice to ourselves if we were to allow it to be supposed that we undervalue either what the late Admiral FitzRoy attempted or what he effected. To his zeal and perseverance is due the credit of establishing a system of Storm Warnings, which is already highly prized by the seafaring class. And if a more scientific method should hereafter succeed in placing the practice of foretelling weather on a clear and certain basis, it will not be forgotten that it was Admiral FitzRoy who gave the first impulse to this branch of inquiry, who induced men of science and the public to take interest in it, and who sacrificed his life to the cause."

June 1867

SEVERE HAILSTORM IN INDIA

"A CORRESPONDENT of the *Madras Athenaeum* at Goommanur,* near Bellary, informs us that very bad weather was recently experienced there. On March 28th a terrific hailstorm swept over the place. All the trees in the neighbourhood were stripped of their foliage, heavy branches were torn down, and many trees torn up by the roots. People's clothes were removed from their backs, and a tent was shivered to rags. The hailstones were as large as cocoa nuts and good-sized mangoes. Some four hundred sheep and twenty head of cattle were killed, as were also several human beings, a large number of whom were severely hurt. Thirty hours after the storm, hailstones were picked up in some of the railway cuttings the size of fowls' eggs" — *Homeward Mail, May 22nd,* 1867. — * Spelt Goomanoor in this article and Goommanur in the second one; the latter is believed to be correct.

"In the early part of April the collector of the Kistna district reported to Government that on the evening of March 27, there occurred a storm of wind, accompanied by rain and hail at the village of Goveravaram, in the Nandigama talook in this district. The hailstones were as big as limes. They continued to fall for about quarter of an hour, and lay on the ground to the depth of span. Men and cattle were reported to have been severely bruised by the hailstones, which remained in heaps unmelted till nine o'clock a.m. the next day. The collector of Bellary also reports that on the afternoon and night of March 28 and 29, a very severe hailstorm passed over this district.

'In Adoni to the north of the talook, at Nukkulmittah and other villages, the hail is described as being of the size from cocoa nuts to woodapples, and lying to one foot in depth; in some places destroying the wet and dry crops. In Gooty, at eight p.m. on the 28th, the hail was described as ranging from the size of bullets to limes; some sheep were killed and crops destroyed. The villages indicated are Hunchinbal, Karakamookkala, and Koncondla. In Anantapur talook the size of the hailstones is apparently incredible. I give, however, the local report that in a field of the village of Bondalavada some of the stones were two-thirds of a cubic yard in size. In the village of Chadula a cubic span, and in other villages of six seers, or three pounds weight; this last was verified by the Tahsildar. Two men, 2,470 sheep, and eight cattle were killed, and some thatched houses were destroyed. In Alur, on March 28 and 29, to south of the talook, at Goormmanur and other ten or twelve villages the hail was described as ranging from the size of cocoa nuts to mangoes, and lying half a yard in depth in some villages, destroying the dry crops, two men were killed, and one carried away by the flood in a nullah close to Goommanur. Looking from the talook of Hospett on that evening, a vast pile of electric clouds was seen towards the east, similar to those which collect on the western coast before the commencement of the monsoon. I have had no intelligence of hailstorms in the western talooks, or from those furthest south, so that as far as I am at present informed, the storm must have extended over the north, centre, and south-east of the district.When further details are received regrading the loss of crops a report will be made, if any, and what consideration should be shown to the sufferers.' Tho collector of Cuddapah reports that a severe storm, accompanied by hailstones of extraordinary size, was experienced in different villages of the three talooks, Pulivendala, Royachoty, and Kadiri. In the Pulivendala talook seven individuals received serious wounds and lost their lives. The storm in the other villages swept away the standing crops and stacks, and also killed some sheep." — *Homeward Mail, June 4th, 1867.*

January 1868

CYCLONE IN BENGAL

ALTHOUGH there is certainly no present proof of community of origin, it is at least a singular coincidence, that almost at the very same moment that Tortola was being laid low by a cyclone unequalled in destructive power for thirty years, "Calcutta was astonished at a return of wet weather," followed in a few days by a violent Cyclone.

The disasters in Bengal were far heavier than in the West Indies but as only three years have elapsed since the former district suffered from one of the most destructive storms on record, the present catastrophe has been deemed less important than it otherwise would have been. The cyclone of October 5th, 1864, swept over Calcutta in the day-time, yet 50,000 lives were lost, and property worth upwards of two millions was destroyed. In 1867 the lives lost are computed at 3000.

The following extracts from the Calcutta *Englishman* give a vivid description of what is often deficient — namely, the premonitions of the storm.

"For weeks past the weather has been a foremost topic of conversation. The rains had apparently ceased, when Calcutta was astonished, on 26th October at a return of wet weather. During all last week rain seemed threatening, and on Thursday the threat began to be fulfilled. The sky on Friday was overcast and lowering, the pall of cloud was unusually low, and masses of scud were whirled swiftly away to leeward all day long. The gloom of the day was added to by frequent rain-squalls; the day, in fact, was just one of those for which November in England has acquired so unpleasant a reputation. As the day wore on the signs of bad weather increased. About three o'clock the barometer began to show signs of falling, and the wind came down in fiercer gusts. Matters remained in this state till dusk, when it was evident to the most careless that Calcutta was about to be visited by a storm, which would rival the now famous Cyclone of 5th October, 1864. Men went home from office to hurry through dinner and prepare for the struggle, and although some daring spirits went to the Opera, they were the exception. At ten o'clock, the fastenings of doors and windows began to be severely tasked, and the storm rushed over the city with a heavy murmurous roar, like a fierce surf beating on a shingle beach. This roar never lulled until daylight, but every few minutes it swelled up into a thunder of wind and rain, marking the approach of heavier squalls. Up to half-past one the storm was content with rattling doors and windows furiously, but now it forced its way into the well-guarded dwellings of the European portion of the city, and tore off here a sash, here a venetian, here a door. The houses shook under the force of the blows dealt them, and often and anxiously were the time-pieces consulted to see how the night wore away. Soon after two, however, there was a sensible abatement of the storm, the gusts were as fierce as ever, but the intervals between them were longer. By half-past three the strength of the gale had greatly abated, and by four the hurricane had become a strong westerly gale, and people began to count up the damage they had sustained, and to hope for daylight, to enable them to ascertain the losses of their neighbours. Few slept last night, and there are few who could wish to pass such another night, or to battle again with a gale which has wrought the city, as much, if not more, injury than even the great cyclone."

"The following is the official report from Mr. Blandford, the Meteorological Reporter, on the storm of Friday night:– On the night of 1st and 2nd November, Calcutta was visited by a severe cyclone, the centre of which passed to the east of Saugor Point and Calcutta, in a northerly direction. Threatening indications were noticed in the telegrams, received on the morning of the 1st, from Saugor Point and Cuttack, and the probability of an approaching storm was strengthened by a report sent from the former place at 12 h. 30 m. These, with the subsequent reports from Saugor Point at 16 h., 17 h. 30 m., and 19 h. were communicated at once to the Master Attendant of the Port, but up to 19 h., the wind at Saugor Point shewed no sign of veering, and it was uncertain whether the cyclone had actually formed. At 20 h. no distinct telegraphic report could be received from Saugor, and the 19 h. telegram is the latest information received thence up to present date. At Calcutta the wind was from N.E., and shortly after dusk became fitful and threatening, the gusts gaining gradually in strength until they reached their maximum between 2 and 3 a.m. of 2nd (?). The wind was at first from the N.E. veering gradually to N. and to N.W., which was its average direction when most severe. The lowest barometric reading at the Surveyor General's office was taken at 3 a.m., viz., 28.6 inches.

"The maximum force could not be recorded, owing to the destruction of the anemometer at 2 a.m. The storm abated, and the barometer rose rapidly after 3 am."

"A native correspondent at Jessore, writing on the 3rd November, sends us the following:-

" 'Jessore has been swept by the terrible cyclone, unprecedented in the history of this little station. From the evening of the 29th October to 11 p.m. of 1st November, it rained heavily. At half-past eleven, a burning brilliant cloud was first observed in the north-east corner of the station. All thought at first that it was a fire, but it was not so; for the storm soon began, and changed its direction as the sky-flame changed its position, i.e., from north to east, to south, to west — to north-west, whence in the morning it disappeared. It was

not a cloud, for clouds were distinctly seen running fast below it. When it was in the north-east several houses at Jhoonjhoonpoor (a small village north-east of the station) were burnt; when it was in the north-west fire set into some of the houses at Poorono Kuslea (a village north-west of this station); similarly to some houses in another village in the east. I have yet received no news from south and west. The fires may have been accidental, but the brilliant flame, which guided the course and direction of the great cyclone, deserves enquiry. The spiritualists here attribute it to supernatural agency, but let the materialists, or the so-called scientific world explain the phenomenon! It was not a delusion, for it as observed by the majority of the residents. I write you to know this, for you have many literary and scientific readers, who, I hope, will kindly come forward and explain to us (ignorant men) the mystery of this mysterious flame! ! !

" 'Except a few *pucca* houses, all gone down! Rice crop at once ruined, prospect of winter crop very gloomy, and the people know not what to do.They attribute all these to the sins of their rulers. I am glad, however, to inform you that our magistrates are doing all that humanity could wish, or energy act.'

"This letter mentions a phenomenon preceding the storm which we do not remember to have heard of before, in connection with cyclones. Several correspondents have, however, spoken of a peculiar luminous appearance in the atmosphere at the height of the storm. The subject is one well worthy of investigation."

February 1881

EDITORIAL AND EXPLANATORY

DURING the past fifteen years it has several times been our duty and our pleasure, by special enlargements, to present our readers with complete accounts of remarkable phenomena. But on no occasion has there been such a strain put upon us, as has resulted from the mass of details furnished respecting the frost and the snow of the past month, which have come in along with sadly too numerous enquiries, "How to measure the snow" from observers who had neglected to read rule XV., which we reprint, in the hope that, with the recent snow-storm in their memory, all our correspondents will read it.

XV. — SNOW — In snow three methods may be adopted — it is well to try then all. (1) Melt what is caught in the funnel by adding to the snow a previously ascertained quantity of warm water, and then deducting this quantity from the total measurement, enter the residue as rain. (2) Select a place where the snow has not drifted, invert the funnel, and turning it round, lift and melt what is inclosed. (3) Measure with a rule the average depth of snow, and take one-twelfth as the equivalent of water. This being a very rough method, is not to be adopted if it can be avoided. Some observers use in snowy weather a cylinder of the same diameter a the rain gauge, and of considerable depth. If the wind is at all rough, all the snow is blown out of a flat- funnelled rain gauge. Snowdon pattern gauges are much the best.

Very fortunately the Council Meeting of the Meteorological Society was held on the night after the snow, and it was then resolved that all the data respecting the frost which could be collected should be forwarded to the Assistant Secretary, Mr. Marriott, who should discuss them and report the results to the meeting of the Society on February 16th. An abstract of this report will be found on page 25, and of course the report in *extenso* will appear in the Society's *Quarterly Journal*. Hence it is that none of the many letters which we have received upon the subject will found in our pages.

We undertook the investigation of the limits of the snow-storm; we applied specially to 150 of our observers and also to the managers or principal officers of the following railway companies, nearly all of whom have taken much trouble in the matter, and rendered most valuable aid, as is sufficiently evident from the letters and tables printed at the end of Mr. Wallis's report.

Although it has been a matter of considerable difficulty to get all this mass of material discussed in time for the regular-date of publication we are satisfied that accuracy has not been sacrificed to speed, and that such subsequent material as may arrive will in no way invalidate the conclusions arrived at in the following article.

Owing to the very exceptional character of the snow-storm many of the monthly returns on pages 30 and 32 are obviously incorrect. All the figures to which the is attached are not necessarily wrong; but the observers are requested to report what they believe to have been the average depth of the snow in their neighbourhood, and the nearest possible approach to the truth will be obtained before the publication of the annual totals. Few rain-gauges will hold 5 inches of snow, many will not hold 3 inches — where, therefore, the fall has exceeded those amounts it is evidently fallacious to report merely what was "found in the gauge." Rule XV., Sections (2) and (3), should have been generally followed, but even then some difficulty existed. It is neither easy nor pleasant to obtain accurate measurements of such a storm; we rejoice to notice the care which many of our observers paid to the matter; that which they have done will not merely render their own records perfect, but will help to check those of their neighbours, and in spite of all difficulties and a terrible addition to our ordinary work, we have no doubt that eventually few records will prove entirely spoilt. — G.J.S.

February 1881

ON THE SNOW STORM OFJANUARY, 1881

BY H. SOWERBY WALLIS, F. M. S.

AFTER the 9th of January snow fell daily on some portion of the British Isles, and on the 12th and 13th rather heavily over the greater part of them, so that by the 17th (on which day practically none fell), there was a considerable depth on the ground over the whole of the United Kingdom, the weather having been so cold that scarcely any had melted. This depth averaged three to four inches over the greater part of England, and rather more in Wales, the N. of England, and in Scotland. During the early morning of the 18th the wind, which was easterly, rapidly increased in force, and blew a strong easterly gale nearly all day, the wind falling again in the south at night, but in other parts of the country it lasted till about mid-day on the 19th. The gale was particularly severe on the east coast, but the number of wrecks and casualties all round our shores was very great; reports from many seaports stating that it was the most severe gale that had been experienced for more than 30 years. Much damage was done to roofs, &c., and a very large number of trees were blown down in the eastern counties — e.g., Lord Rendlesham reports over 1,500, most of them large ones, blown down on his estate, and there were many isolated cases of structural damage in other parts of the country. In London an extremely high tide, increased by the gale, overflowed the low-lying districts on the south of the Thames, causing great distress, augmented by the extreme severity of the weather, among the poorer classes.

The gale was accompanied by a heavy and steady fall of snow over all but the north of England, which lasted through the 18th and continued, though rather lighter, till about noon on the 19th. The amount of snow deposited over the whole of the southern portion of the country was very great, and was so drifted by the fierce wind, that communication both by rail and road was entirely disorganised, and it was more than a week before the railway and postal arrangements throughout the country recovered their usual regularity and punctuality; the interruption to business was further increased by the large number of telegraph wires which were broken by the gale or by contraction caused by the extreme cold.

Snow fell again on the 20th in the S; and S.W., very heavily in the Isle of Wight and neighbouring districts, blocking up many lines of railway that had with great difficulty been cleared from the fall of the 18th.

Among careful observers in all parts of the country where the snow fell with its full intensity, it appears to be the general opinion that to find anything like a parallel case we must go back to 1836 or to 1814; and it would appear that in most parts of the country the depth in those years was greater, but that the drifts were not so great. As regards the fall in the Isle of Wight and South Hampshire, it is believed to be altogether unprecedented in recent times.

One feature of the snow which appears to have been noticed nearly all over the country, was its extreme fineness and dryness, and the remarkable manner in which it penetrated in large quantities through roofs, the cracks of doors and windows, and even the most minute and almost imperceptible crevices.

The loss of life in England and Wales, entirely due to the snow, was very great, and probably an estimate of 100 persons would be very near the truth, and the amount of distress occasioned simply by the stoppage of the supplies of food and fuel to country districts from towns is almost incalculable.

Small birds died of starvation in vast numbers, their food being covered by the snow. At Littlehampton, in one shrubbery, more than 100 dead blackbirds and thrushes were found, and the following curious incident is reported in an Isle of Wight newspaper:– "A friend of ours looking from his window (in Shanklin) on Monday, saw some larks hopping about on his lawn. Presently some rooks swooped down upon the birds, tore several to pieces, and ate them."

It is very difficult to realise the magnitude of the snowstorm and of the drifts; perhaps some of the men employed in clearing the railways had the best opportunity of doing so. Locomotive engines and trains, in spite of their size and power, were snowed up by the dozen; not merely stopped, but buried for days together, and in some cases so completely as to be quite hidden. From the Tring cutting on the L. & N.W. railway, 1,700 truck loads of snow were taken. A railway truck is about 15 ft. long, therefore 1,700 trucks would form a train nearly five miles long. A train five miles long to empty one cutting on one railway, what length of train would it require to remove the snow from all the cuttings on all the railways in England?

The loss to the country was enormous; over more than half England business was practically stopped for one day at least, and the cost of clearing not only the railways but almost all the roads in the country, is incalculable, not to mention the more or less serious suffering and discomfort. Plymouth was deprived of water for nearly a week. Public and private meetings of all kinds had to be postponed; in short, that intercourse between man and man, on which the whole business and pleasure of life depend, was interrupted.

The accompanying map and following summaries for the different counties are founded on special returns from about 200 regular meteorological observers, and on the reports furnished by nearly all the great railway companies, which are especially valuable, as they are

DISTRIBUTION OF SNOW

January 17th to 21st, 1881

For explanation see page 300.

based on statistics furnished by the engineers and traffic superintendents of the various lines, who not only had special opportunities of ascertaining the various depths, but who are in the habit of dealing with accurate measurements, and are, therefore, less likely to be led into unconscious exaggeration than amateurs of all classes.

The depths of snow in the various cases must be understood to represent the greatest depth to which the ground was covered at my time between the 17th and 21st of January, as it was impossible to deal with it in any other way; but except in the extreme S. and S.W., by far the greater portion of it fell during the one continuous storm of the 18th–19th.

The map shows at a glance where the greatest amount fell. Over the white portion the depth exceeded 12 inches, and the part left black is where no appreciable amount fell on the 18th and 19th; the shaded portions represent respectively where the depth was less than 6 inches, and where it was between 6 and 12 inches.

There was also snow on the ground over almost the whole of Scotland and Ireland, which drifted considerably, and in some cases caused delay to traffic; but it has no interest in connection with the abnormally heavy fall of the 18th and 19th over the southern portion of England, and therefore needs no further notice. The special feature being that the heaviest falls occurred in those parts of the United Kingdom where ordinarily such falls are most rare.

List of Railways supplying data

Great Eastern
Great Northern
Great Western
London and North Western
London and South Western
London Brighton and S. Coast
London Chatham and Dover
Manchester, Sheffield and Lincolnshire
Metropolitan
Midland. *Reply too late for this month*
Somerset and Dorset
South Eastern. *Report not yet received.*

April 1885

FLOATING MID-ATLANTIC METEOROLOGICAL OBSERVATORY

INASMUCH as most of the changes in British weather are due to the passage of cyclonic systems which are traversing this quadrant of the globe from some Westerly towards some Easterly point, it is obvious, and generally recognized, that it is more difficult to forecast the weather which will occur on the West coast of Ireland than in any part of Europe.

It has never seemed to us a very wise arrangement that this forecasting should be done in the extreme East of the British Isles, in London, instead of at a Western centre such as Galway; but that is not the point now before us.

The great difficulty in forecasting British weather is the lack of information from the Westward. Excepting the Azores (and they are so far South as to be of little use), there is nothing but ocean West of Ireland until we reach Newfoundland.

Let us not, however, be misunderstood and said to be adverse to the establishment of regular communication with the Azores. By itself we believe that a daily telegram from the Azores would be, as we have said, "of little use" in forecasting British weather; but we think that it would be quite otherwise as regards the more Southern countries of Europe, and if obtained primarily for their benefit, should certainly be reported to our own office.

From the vast stretch of ocean between Ireland and Newfoundland there has hitherto been only one way of obtaining information, viz., that for which the credit will ever remain due to Mr. Gordon Bennett, of the *New York Herald*, and his clever meteorological assistant, Mr. Collins (who perished in the ill-fated Jeanette expedition). His plan was to combine the information of cyclonic movements on the American Continent as obtained from the Signal Office, with the meteorological data for the ocean as stated in the log books of Transatlantic steamers arriving at ports on the Eastern coast of America; he was thus able to track the cyclones after they left the American coast, and hence infer the trajectory which they would probably follow, and their velocity in it.

Collins, as we have said, perished in the Arctic regions. Had he still been alive, we should certainly have heard some comments from him upon the fact that while Mr. Bennett was at his own cost sending the telegrams to this country, they were stated to be useless and yet, eight years after they were commenced (the first *New York Herald* warning was sent February 14th, 1877*), we find the English Meteorological office arranging with the American Signal Office for the transmission of telegrams (at whose cost we do not know) with precisely the object for which Mr. Bennett sent them.

*Comptes rendu Congrès Internationale de Météorologie.–Paris, 1879, p.110

All this, however, is introductory to, and justificatory of, what we are going to plead for — viz., a floating Meteorological observatory in about Latitude 50° N. and Longitude 20° W. Of course, the first remark that will be made upon the proposal is that it is an impossibility, and the second that the idea is a very old one.

We are aware that the depth of the ocean at the above spot is about 2,000 fathoms, about 2¼ miles, and that a mooring chain of that length would be a novelty — but the days when novelties are regarded as impossibilities have surely passed. Is no encouragement to be derived from the fact that broken telegraph cables have been picked up at even greater depths, and raised to the surface. The precise locality is not, however, to be decided wholly on Meteorological considerations, Meteorologists have little chance of raising necessary funds, and the Observatory must be also a call station for passing vessels and for those in distress, and these conditions may require a different locality.

We start afresh with some more scraps of history. The first must be very incomplete, since we cannot lay hands on any printed account. About twenty years ago an attempt was made to establish a "call station" for merchantmen entering the Channel, by placing a vessel somewhere South of the Lizard, which vessel had telegraphic connection with the main land. We believe that the vessel was not constructed specially for the work, and the connection was so often broken, that eventually the scheme was abandoned.

The idea of establishing electro-telegraphic communication with ships in shallow water is by no means given up. In the Fisheries Exhibition of 1882 there was at least one full size specimen of a connection adapted for a light-ship, and some such connection has actually been fitted to, and is working from the "Sunk" light-ship nine miles distant, to the coast at Walton-on-the-Naze.

At the Fourth Annual Exhibition of Instruments, held by the Royal Meteorological Society, March 21st, 1883, there was an exhibit thus described in the catalogue:-

"78.— Cartoon of a Vessel designed for automatically compressing and storing air by means of the waves of the sea, and for the generation of electricity by means of this compressed air. The inventor considers that the vessel can be used as a telegraph ship, and is capable of being moored in 1000 fathoms of water, and connected with the shore at any distance with an electric cable.

"*Exhibited by* C.W. Harding, Assoc. M.I.C.E."

We believe that we are correct in supplementing this by the statement that Mr. Harding had a small vessel built for experimental trial, and that it was moored off the Norfolk coast.

Lastly, but by no means least, we reprint from our excellent contemporary, the *American Meteorological Journal* for March, the article which has led us to draw special attention to the subject — one which, for the reasons stated at the beginning of our paper, is of infinitely more practical importance to us than to our American friends; for such a station would rarely be able to warn them, and on the contrary would almost always be able to help us:-

METEOROLOGICAL STATIONS IN THE ATLANTIC

The widespread and increasing interest taken the information furnished by the U.S. Signal Service, as shown by requests to establish signal stations throughout the country, should met by establishing meteorological stations in the Atlantic over or near the commercial cable lines, when they would be in communication with both sides of the Atlantic.

The practicability of such stations has been demonstrated by the cable-laying steamship *Faraday* while laying the cable between France and the United States, and, holding on to the cable, found herself in the course of a cyclone which passed directly over the vessel without causing her to lose her hold of the cable, and which was at once reported to the European continent, the report giving wind changes and velocity with barometric changes. It is also demonstrated by the light-ship off Frying Pan Shoals, N C., which is anchored about twenty miles from shore, where it is exposed to the severe storms that occur off the Carolina coast. The value and importance of such stations is apparent; continuous observations could be had, not otherwise accessible; storms could be traced throughout their entire course, and the observations in connection with those of the signal stations on the Atlantic coast would decrease the danger arising from sudden storms.

The steamships of the great ocean lines and others could be warned by signal of storms raging across their path; communication by means of signals could be held with vessels, and vessels reported to owners; proximity of icebergs and wrecks reported, and it might be the means of saving many lives. If but one life were saved, it would compensate for the expense of establishing and maintaining stations. The stations, under control of chief signal officers of the army, and manned by observers of the Signal Service, would add valuable data to the science of meteorology.

F.S. COBURN
New River Inlet, N.C., January 25.

To this it may be added that the recording instruments recently brought out by Messrs. Richard Frères will all work on board ship, and thus we could have a floating observatory with continuously recording instruments, a gain of considerable importance.

How many years will the weather forecasters of Europe have to rely upon conjecture, owing to the non-establishment of such an observatory as above suggested?

March 1900

GEORGE JAMES SYMONS. F.R.S.

London, 6th August, 1838 — 10th March, 1900

THE Founder of the British Rainfall Organization and of this Magazine has passed away after a life, long in good work, though short of the allotted threescore years and ten.

In 1857 he started an organization for observing and recording thunderstorms, and soon after began the great work of his life in connection with British Rainfall. The first published volume contained the records for the year 1860, while the fortieth will be issued within a few months of his death. With 1866 he commenced the publication of the *Meteorological Magazine*, and this is the first number which has contained no article written by him.

For forty-four years he was a Fellow of the Royal Meteorological Society, and for twenty-seven years was its Honorary Secretary, except during three years when he occupied the presidential chair, to which he had this year been again elected as being best fitted to support the Society in the celebration of its jubilee. For forty-two years he supplied monthly records of meteorological observations to the Registrar-General; for forty years he was a member of the General Committee of the British Association, and served on many Committees; and for nearly forty years he was a member of the Scottish Meteorological Society. For twenty-seven years he was a member of the Société Météorologique de France, and served three times on the Council.

There is no need here to enlarge upon his work, but in illustration of his widespread activity may be mentioned "Notes on the Solar Eclipse of July 18th, 1860," "Meteorological Statistics and Bibliography of the Colonial Empire," "Inquiry into the Temperature of the Thermal Springs of the Pyrenees," "The Floating Island in Derwentwater," "The Lightning Rod Conference," "The Eruption of Krakatoa," and "Cowe's and Merle's Meteorological Registers," besides his great contribution to the bibliography of meteorology.

The honours of work fell to his share more than those of mere compliment, and he was elected president of innumerable congresses and committees at home and abroad, and Juror at meteorological exhibitions both in England and on the Continent. He received a Telford premium of the Institution of Civil Engineers in 1876; in 1878 was elected a Fellow of the Royal Society, was created a Chevalier de la Légion d'Honneur in 1891, and was selected by the Prince of Wales to receive the Albert Medal of the Society of Arts for 1897.

His great kindness and genial personality were known almost the world over, and among his innumerable colleagues on the Councils of the Royal Society, the Royal Meteorological Society, the British Association, the Société Mét. de France, the Royal Botanic Society, the Sanitary Institute, and on numerous other bodies, he is not known to have made a single enemy. The great majority will sincerely mourn his loss as that of a true friend, and will be able in some measure to appreciate what it must be to the writer of this brief memoir who has worked with him daily and hourly for nearly thirty years, and who is proud to have been selected by him as his successor in the work.

H. SOWERBY WALLIS.

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Introductory Note.

WITH the first issue of *The Meteorological Magazine* as the official organ of the Meteorological Office, a few words of introduction may be desirable. Since 1916 the Office has issued each month a Circular, which has been found of value for the publication of official information and for the exchange of opinions on current meteorological topics. On the absorption of the British Rainfall Organization, the Office became respoisible for the continuance of *Symons's Meteorological Magazine*, which had been closely associated with that Organization throughout its long history. The continued existence of two separate publications was obviously undesirable, and the *Meteorological Magazine* is to be issued instead. For convenience in reference the serial numbers of *Symons's Meteorological Magazine* are being carried on.

With regard to the *Meteorological Office Circular* it may be noted that a classified index has been prepared. Typed copies of convenient size for binding will be supplied on application to the Office.

Contributions to the *Meteorological Magazine* from Observers and others who take an interest in the weather will be welcomed by the Editors, to whom they should be sent not later than the 5th of the month.

February 1920

Retirement of Sir Napier Shaw,

Sc.D., LL.D., F.R.S.

THE retirement of Sir Napier Shaw from the Directorship of the Meteorological Office, on the completion of the third term of his appointment, will be received with regret by all who have been associated with meteorological work in this country and abroad. Sir Napier's connection with the Office has extended over 40 years, for it began in 1879, when, at the request of the Meteorological Council, he undertook an experimental comparison of the various methods of determining the hygrometric state of the air, the results of which were published in the Philosophical Transactions of the Royal Society in 1888. In 1897 he was appointed a member of the Meteorological Council to fill the vacancy caused by the death of Mr. E.J. Stone, F.R.S. In 1900 he succeeded the late Dr. R.H. Scott as Secretary to the Council. From that date the work of the office has been carried on under his immediate supervision, and the present eminence to which the Office has attained is due in no small measure to his personal initiative and "drive".

In 1905 the direction of the Office became vested in the Meteorological Committee appointed by the Treasury, with Sir Napier as Director and Chairman of Committee. Busy years followed. The planning of the new office building at South Kensington occupied much time and thought. It was to be no mere office, but a centre for meteorological and geophysical research, with ample library accommodation and a museum in which the results obtained might be adequately displayed. The building was completed in 1910 and the transfer from Victoria Street was accomplished in the summer and Autumn of that year. The educational side of the Office work benefited immediately and parties of students and teachers visiting the establishment to acquire at first-hand a knowledge of meteorological practice were frequently met with at the Office.

The transfer to the Meteorological Committee of responsibility for the work of the Observatories at Kew and Eskdalemuir in 1910 further widened the scope of office work and increased the duties and responsibilities of the Director. The Office ceased to be a purely meteorological institution and became the official centre for carrying out geophysical investigations, terrestrial magnetism, atmospheric electricity and seismology.

In the purely meteorological sphere, in addition to extending the work of the forecast service and of the stations and observatories directly under the jurisdiction of the Office, Sir Napier was ever anxious to bring the large number of voluntary observers into relation with the Office in order to render their work readily available for the public good. He devoted much time and thought to devising arrangements for supervising such voluntary work and directing it along useful lines. — The publication of summaries of approved observations in the *Monthly Weather Report* was the chief means adopted for attaining this end, and the Report came to be regarded as an index of the material available in the Office for "keeping the public memory of the weather."

The twenty years of Sir Napier's control of the Office have witnessed a rapid development of upper air research in this and other countries, and it became necessary to see that the Office took its proper share in this pioneer work. The spending of the available funds in a manner to secure the best results was no easy task. Sir Napier was fortunate in having the assistance of Mr. W.H. Dines, F.R.S., in this part of his work. He was singularly happy in devising arrangements under which Mr. Dines was enabled to carry on his individual work at Pyrton Hill, and subsequently at Benson, and bring it into close co-operation with the work of the Office. He was equally fortunate in securing co-operation between the Office and institutions like the upper air observatory of the University of Manchester or the private observatory of Capt. C.J.P. Cave, of Ditcham Park.

In international meteorological work Sir Napier was also called upon to play a large part. He became a member of the International Meteorological Committee soon after his appointment as Secretary to the Meteorological Council, and on the retirement of M. Mascart he was elected President of the Committee at the meeting held in Paris in 1907 From that time onwards he was constantly called upon to deal with questions of international co-operation between the meteorological services of different countries.

It had been Sir Napier's often expressed intention to resign from the Directorship in 1915 in order that he might have leisure to devote himself to furthering the academic side of meteorology, but the outbreak of war put all idea of resignation out of question, as it soon became clear that the national emergency would make great demands on the Office. Limitation of space makes it impossible to detail the steps which led to the formation of the separate meteorological services established by the Army, Navy and Air Force, but the Office organisation had to supply the essential information for all these, and to supply or undertake the training of a large part of the personnel required. The demands were not only for weather forecasts, but for help in the applications of meteorology to gunnery, aircraft construction and navigation, and numerous other subjects. The work of directing the Office operations became more than one man could accomplish, and arrangements were made, with the consent of the War Office, for Colonel H.G. Lyons to undertake the

administration of the Office, leaving Sir Napier free to devote himself to the scientific problems which he was eminently fitted to solve. Among other things the need of an advanced text-book of meteorology for the training of expert personnel became acutely felt, and Sir Napier met that demand by compiling the *Manual of Meteorology*, of which Part IV., dealing with the relation of wind to the distribution of pressure, was issued early in 1919. The first three parts are still to come.

Some months after the signing of the armistice Colonel Lyons relinquished his temporary position as administrative head of the Office and the full responsibility once more evolved upon Sir Napier. During the months that have intervened the control of the Office has passed to the Air Ministry and Sir Napier has had to carry through the unification under a single control of the independent services established during the war. Another important step in the unification of meteorological work in this country also occurred at this time, namely, the transfer to the Office of responsibility for the work of the British Rainfall Organization, which took place during the summer of 1919.

We are glad to learn that Sir Napier's retirement from the Directorship does not involve his complete dissociation from active meteorological work at South Kensington. He has undertaken the duties of the Professorship of Meteorology at the Imperial College of Science and Technology in connection with the School of Aviation recently established there in association with the University of London, and as such will, with the courtesy of the Air Ministry, retain the use of a room in the building which he was instrumental in calling into being. The good wishes of all will go with Sir Napier in his new work.

September 1920

A Conference at Bergen

An extract from the Report by Sir NAPIER SHAW, Sc.D, LL.D., F.R.S.

ON the invitation of Professor V. Bjerknes, Director of Section B. of the Geophysical Institute, Bergen, a delegation of the Meteorological Office visited Bergen for the purpose of inspecting new methods of forecasting which have been developed by the meteorological staff of the Institute under the direction of Professor Bjerknes. The Geophysical Institute consists of two sections, viz., A., the Oceanographical Section, under Professor Helland-Hansen, who is also the Director-General of the Institute, and B., the Meteorological Section, under Professor Bjerknes.

The invitation had the practical support of the Bergen Steamship Company and the Bergen-America Line on account of the interest of these companies in the development of meteorological methods with a view to forecasting for North Sea steamers and ocean liners. The companies observe for the Institute at 8 h., 14 h. and 20 h. Norwegian time, and transmit their observations by wireless telegraphy for incorporation with other data on the regular maps.

The invitation was extended to four or more representatives of the Meteorological Office. The delegation consisted of Sir Napier Shaw, Director, Colonel L.F. Blandy, Controller of Communications, with Major A.H.R. Goldie, Mr. L.F. Richardson and Captain C.K.M. Douglas. The delegation left London on July 17th for Newcastle and landed at Bergen on the morning of July 19th. The members of the staff of the Bergen Institute who took part in the proceedings, besides Professors Bjerknes and Helland-Hansen, were Mr. J. Bjerknes, Mr. B. Björkdal and Mr. Rossby, who are in charge of forecasts, Mr. Fjeten, who is in charge of instruments. Professor Hesselberg, Director of the Norwegian Meteorological Service, came from Christiania, and Mr. Bergeron, a former assistant at Bergen and now in the Hydrographic-Meteorological Bureau of Stockholm, came with his colleague, Mr. Calwagen, from Stockholm. Dr. Jakobsen, a Danish oceanographer, was also present with Professor Helland-Hansen, and Mr. Jon Eyporsson, who is in training for the Meteorological Service of Iceland.

The ordinary daily programme of business was to meet in a lecture-room of the Bergen Museum in the morning (which lasts till 15 h.) for the discussion of scientific questions, and later in the afternoon to visit the Institute to inspect the working charts for the day and to consider as a committee the administrative aspects of the questions raised. This plan was followed on July 20th to 24th inclusive and July 27th to 30th. Proceedings commenced with a lecture followed by discussion, and the reading and discussion of supplementary papers.

The projects which the visit was designed to develop have arisen out of a discovery by the Bergen Institute, principally by Messrs. Solberg, J. Bjerknes and Bergeron, that the phenomena of the weather of the Northern Hemisphere are largely dependent upon the surface of junction of polar and equatorial air which can be detected at the earth's surface as a line of discontinuity in the conditions of pressure, temperature, wind-direction and force, humidity and visibility. The line of discontinuity passes through the centres of cyclones and connects the centre of one cyclone with

those of the preceding and succeeding ones by a line which can be identified somewhere in the westerly current lying on the south side of the line of centres of cyclones. It may possibly be as far south as the margin of the permanent Atlantic anticyclone, and it may even be carried round with the north-east trade to the southern margin of the anticyclone. The polar air is identified at the surface as being cold, dry, very transparent, and often blowing from some easterly point, and the equatorial air as relatively warm, moist, with poor visibility, and always blowing from some westerly point.

The surface of demarcation between these two types of air is called the "polar front," which is divided into the "steering surface" or "anaphalanx" from the front margin of the cyclone to its centre, the intermediate section between the margin of successive cyclones, the "squall surface" or "kataphalanx" from the centre to the rear margin. Attempts to identify the line in which the polar front cuts the earth's surface on the detailed maps of Western Norway have apparently been generally successful, and it extension over Western Europe and ultimately round the earth is obviously a practical proposition. The complete front must be regarded as a surface of irregular shape extending from the line marked out at the earth's surface obliquely upward to a considerable, but at present unknown, height. The Bergen investigators set no limit below the stratosphere (say 33,000 feet). *A priori* we should regard it as belonging to the peculiar juxtaposition of relatively warm and cold air which is inevitable at the surface but not to be expected in the upper layers; observations in aeroplanes have, however, been adduced in support of the Bergen views. They associate most of the phenomena of cyclones with different parts of the polar front, and in particular on all their maps they set out definite rain areas in connection with the anaphalanx and the kataphalanx, the two parts of the front that meet in a cyclonic centre; and they use the two parts of the line in which the front cuts the surface (provisionally called the steering line and the squall line) as axes meeting in the cyclone-centre: to one or other of which they refer all the weather incidental to the passage of the cyclonic depression. The sector of the cyclone within the angle between the anaphalanx and kataphlanx they call the "warm" sector of equatorial air, and endow it with showery possibilities but not continuous rain.

Moreover, they find that the one part of the polar front the kataphalanx may encroach to such an extent on the warm sector as to reach the steering line or surface line of the anaphalanx and ultimately overlap it; thus it will cut off an isolated patch of the equatorial air, upon which the warm sector of the cyclone depends for its existence, and will bring about the "death" of the cyclone.

As to the nature and origin of cyclones, Professor Bjerknes, relying upon a proposition of Helmholtz that in consequence of the rotation of the earth the surface of separation at a discontinuity between polar air (or air moving eastward) would not be vertical, but would tend to become parallel to the earth's axis of rotation and therefore inclined to the vertical anywhere except at the pole, is developing a theory of the motion of air in a cyclonic depression as the result of wave motion, different in character on either side of the polar front and advancing in the inclined surface of separation which forms the front.

In consequence of these developments the Bergen meteorologists have come to consider that a new step in advance in practical meteorology is possible, and indeed almost certain, if attention is concentrated upon this new feature, viz., the polar front.

The more serious business of the meeting was interrupted for the 25th and 26th July for an excursion, on the invitation of Professor Helland-Hansen, to Väring Voss, at the head of the Hardanger Fjord, which was reached partly by rail, partly by motor over remarkable roads, and partly by the motor ship *Armauer-Hansen*, a craft belonging to the Oceanographical Section of the Geophysical Institute for the purpose of investigation of the fjords and the ocean. This afforded an opportunity of inspecting the methods of investigation of physical oceanography.

January 1940

A Pilot Balloon Returns to its Starting Point

At 17h. G.M.T on February 23rd, 1939, a 150-in. pilot balloon with an assumed rate of ascent at 700 feet per minute was released from one of H.M. ships lying in Palma Bay, Majorca.

Observations were abruptly curtailed by the balloon entering a layer of stratocumulus; but up to the moment of its loss to view, it had been carried to the north-eastward at a mean velocity of 45 knots.

Twenty-four hours later a balloon was observed, partly deflated, but with only a slight negative atmospheric buoyancy, resting lightly on the surface of the sea, and drifting past the ship in a westerly surface breeze. On recovery it was identified as that which had been released the previous evening. A pin-prick leak was the cause of descent.

Taking 7h. G.M.T. on February 24th as approximately the mean instant of the balloon's flight, the synoptic chart for this hour shows a depression (about 993 mbs.) centred 100 miles north-west of the ship.

There are two possible solutions to the cause for the balloon's return.

(1) It was carried anti-clockwise round the depression, getting extremely close to the centre whilst in the lower layers, and diverging again at higher altitudes, the reverse taking place on descent.

(2) It obtained its northerly and westerly travel from the cyclonic winds in the east and north sectors of the depression, and at a height of 15,000 feet or more entered the steady north-westerly stream which exists almost continually over the Mediterranean in the upper half of the troposphere. Single theodolite observations of ascents up to assumed heights of 20,000 to 25,000 feet on the previous few days during clearer weather had shown that the predominant wind was from 290°, at speeds varying with the time of day from 20 to 35 knots. Unfortunately no Spanish reports were available from which to enable the upper winds to be traced farther afield or possibly fix the position of a front.

In any case there seems little doubt that the balloon travelled at least 400 miles, and its return to the starting point was the result of an unusual and interesting combination of wind components.

P. G. SATOW.
H.M.S. "Vernon," Portsmouth. October 26th, 1939.

January 1947

FOREWORD

BY THE DIRECTOR OF THE METEOROLOGICAL OFFICE

(Sir Nelson Johnson K.C.B.)

The publication of the *Meteorological Magazine* ceased with the issue for June, 1940. The deciding factor was not so much the need for saving paper as the urgent necessity at that time of conserving manpower. The nation could not afford the time of the type-setters and other operatives involved in producing a journal of this kind.

It was not until publication had actually stopped that the value of the *Meteorological Magazine* was fully realised. We had not appreciated the important part it played as a means of keeping us informed of technical developments, as a link between Headquarters and outstations, and as a forum for the discussion of interesting technical points.

The zeal of the Editor, Dr. Brooks, did not allow the *Meteorological Magazine* to suffer complete eclipse, and a typescript edition, complete with diagrams and photographs, maintained a limited circulation. Some of the most interesting features which appeared in the "emergency" edition will be reproduced in the early numbers of this 1947 volume.

With the resumption of normal publication it is hoped not only to regain the original advantages which the magazine provided, but to make it of even greater value and interest than before the war. Articles will be included from time to time dealing with international meteorological matters, which will enable the meteorologist to appreciate how his own work fits into the general world pattern. There will be authoritative articles in simple non-technical language on the work of different sections of the Meteorological Office, and on interesting phenomena which occur from time to time. Regular accounts will also be given of the activities of the Meteorological Research Committee with an outline of the more important papers discussed at its meetings. It is further proposed to include a certain number of original papers on investigations carried out in the Meteorological Office, although the longer papers of this

type will continue to be published as *Geophysical Memoirs* and *Professional Notes* as in the past. Articles will be given describing important developments, such as the recent decision to establish a network of weather reporting ships in the North Atlantic, and explaining the part which the Meteorological Office will play in the scheme.

Although the *Meteorological Magazine* has hitherto been intended primarily for the staff of the Meteorological Office and its collaborators, it is hoped that it will find many regular readers amongst those who worked with us for the first time during the war, and also amongst those members of the community at large who, while having no official connexion with the office are yet interested in the weather and the State weather service.

N.K. JOHNSON

February 1947

OCEAN WEATHER SHIPS

BY COMMANDER C. FRANKCOM, R.N.R.

History. — Prior to the year 1936, synoptic observations from the sea were provided almost entirely by voluntary observers in merchant ships, apart from those obtained from the relatively small number of naval vessels. These observations, although extremely valuable to the forecaster, were necessarily restricted in nature, and more or less haphazard as regards position.

As transoceanic aircraft became a possibility, it became obvious that more detailed information was necessary than could be obtained from voluntary observers in moving ships in order to provide meteorologists and aircraft with accurate information about weather conditions at sea, both on the surface and in the upper atmosphere.

In 1936–7, the British Meteorological Office placed a meteorologist aboard a cargo steamer on the North Atlantic trade route during several voyages and obtained a regular series of special synoptic observations as an experiment. Visual observations of cloud heights and of upper winds were obtained in this ship by the use of pilot balloons.

In 1938–9, the French Government fitted up the merchant vessel *Carimaré* as a stationary meteorological ship in the North Atlantic. Observations of conditions in the upper atmosphere by radio-sonde were successfully obtained in this ship as well as those of surface conditions, and results transmitted by radio. At about the same time, the Germans had two special vessels performing similar functions in connexion with their trans-oceanic airways — one operating in the North Atlantic and the other in South Atlantic. The British Meteorological Office was exploring the possibility of fitting up a vessel specially for this type of work in the summer of 1939.

The war of 1939–45 put an end to all the above activities, and in the early part of that war observations from the oceans were only obtainable from naval vessels and from aircraft. As the war progressed, both sides used various ingenious methods to obtain weather observations from the oceans for their own use. In the latter part of the war, owing to the large number of Allied aircraft regularly crossing the Atlantic, the United Kingdom and United States authorities employed a number of small naval vessels as stationary meteorological ships in that ocean.

When the war finished, the naval stationary vessels were gradually withdrawn, and observations were once more obtainable from merchant vessels. It was realised however, that such observations were not sufficient, and early in 1946 the Conference of Directors of the International Meteorological Organization at a meeting in London passed a resolution urging the establishment of stationary meteorological ships in certain ocean areas. Shortly afterwards, the Provisional International Civil Air Organization (PICAO) Passed a similar resolution in Dublin. In the summer of 1946, at a meeting of the member states of PICAO in London, it was agreed that a total of 13 stationary meteorological ships would be established in the North Atlantic by July, 1947.

The PICAO Agreement. — The United States, Canada, France, Holland Belgium, Norway, Sweden, Great Britain, Eire, Denmark, Iceland, Portugal and Spain were all signatories to the "Ocean Weather Ship" agreement. It was agreed that the allocation of stations would be as follows:—

United States	7
Canada and United States, jointly	1
France	1
United Kingdom	2
Norway, Sweden and U.K. jointly	1
Holland and Belgium, jointly	1

Eire agreed to provide an annual monetary contribution towards the scheme. It as decided that Portugal, Denmark and Iceland already contributed sufficiently to the safety

Met.O.1010

THE METEOROLOGICAL MAGAZINE

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The responsibility for facts and opinions expressed in the signed articles and letters published in this magazine rests with their respective authors.

INDEX

	Pages		Pages
January	1–24	July	153–176
February	25–52	August	177–200
March	53–80	September	201–228
April	81–104	October	229–256
May	105–128	November	257–288
June	129–152	December	289–328*

*December is a special edition to mark the cessation of the magazine and contains selected articles taken from past issues. These articles are not included in this index.

of transoceanic aircraft by the establishment of meteorological stations in the Azores, Greenland. and Iceland respectively.

It was decided that on an average it would need at least two ships to maintain one ocean weather station. The minimum size vessel which could satisfactorily perform the necessary duties was considered to be one of about 1,300 tons displacement, having a length of about 200 ft. and being of a suitable type for North Atlantic work.

The duties of the ship would include:

(a) *Meteorological observations.* — Surface observations every three hours. Special observations, when necessary, of meteorological phenomena and of important changes in the weather.

Upper air wind observations by radar methods not less than four times daily.

Upper air temperature, pressure and humidity by radio-sonde not less than twice daily.

All the above observations would be reported by radio at the appropriate international hours. In addition, observations from certain merchant ships and other ocean weather ships would be collected and re-transmitted by radio.

(b) *Search and Rescue Services* — for aircraft and shipping in distress, as necessary, for which the requisite equipment will be provided aboard the ships. This implies the provision of special boats and other life-saving equipment, radar and special radio equipment, including beacons on which aircraft can "home". The general scheme is that aircraft in distress can "home" on the ocean weather station and alight near enough for a rescue to be effected.

(c) *Navigational aids to aircraft in flight*, for which special radio beacons will be fitted aboard the ships.

(d) *Oeanographical and other scientific observations* as far as it is practicable.

The attached map (*not printed here*) shows the agreed distribution of the ocean weather stations, together with an approximation of the usual transatlantic steamer tracks. It should be emphasised that the establishment of these ocean weather stations will not in any way lessen the importance of observations from merchant ships. The network of observations from the oceans can never approach the density obtainable from stations ashore, but the closer the density the more able is the meteorologist to forecast coming weather changes. The ocean weather ships will merely approximate to islands from which regular observations, both on the surface and in the upper air, are obtainable - the immense gaps being filled in by observations from merchant vessels. It is hoped that the establishment of these stations will not only further the safety of transoceanic aircraft and shipping, but that they will also be the means of greatly improving the accuracy in forecasts for the benefit of the whole community.

The British plan for the operation of their two stations is to employ four ex-naval corvettes of the "Flower" class. These vessels are about 200 ft. in length, are built on whaler lines and have a loaded displacement of about 1,400 tons. They are oil-fired steam vessels, having reciprocating engines and a single screw, and a maximum speed of about 16 knots, economical speed 9 knots. They have established a reputation for being excellent sea boats, having been employed on convoy escort and other duties in the Atlantic, in all weathers, during the recent war.

The British ocean weather ships will carry civilian crews, and they will be administered by the Meteorological Office. Special accommodation will need to be fitted to house the crew of 12 officers, 20 petty officers and 22 ratings, to the modern standards laid down by the Ministry of Transport. A steel shelter will be erected on deck for the filling of radio-sonde balloons; special radio equipment, radar and motor lifeboats will need to be fitted. The work of conversion of these vessels will be carried out in Admiralty Dockyards. It is probable that the ships will be based in the River Clyde area.

The photograph facing p. 32 shows H.M. corvette *Snowflake*, one of the vessels which has been allocated to the Meteorological Office. It will be appreciated that with the removal of her guns and the structural alterations necessary to convert her to an ocean weather ship her appearance will be considerably altered.

In addition to a normal complement of Deck and Engine Room officers and ratings, stewards and cooks, the ships will carry meteorologists and radio technicians. It is anticipated that each vessel will spend about 27 days at sea. followed by a spell of 15 days in port — which latter period is necessary for leave to be given to the ships' companies and for necessary repairs, storage and refuelling to be carried out. It is anticipated that the accommodation and food aboard the ships will be good and that generous leave will be given to the ships' companies.

When on station, in the Atlantic, the ships will, as far as possible, remain "hove to", more or less head on to the wind and sea. Navigation will need to be accurate to ensure remaining in the vicinity of their station, as far possible, within reasonable limits in all weathers, but the ships will of course, make way through the water and vary their position from time to time. Life aboard these small ships at sea will be relatively exacting, at times monotonous, at times exciting — but for the man who likes ships and the sea an the study of the weather, it will, in general, always be interesting. The work will undoubtedly be unusual, and apart from its importance for scientific and practical meteorological purposes, its potential value for the safety of human life is without question. Those who go down to the sea in ships . . .

April 1947

THE CENTRAL FORECASTING OFFICE, DUNSTABLE

BY E.G. BILHAM, B.SC., D.I.C.

(The figures referred to in the text have been omitted, the first is well described, the second too complex to warrant the effort here, the photographs not good enough.)

On February 4, 1940, the Forecast Branch of the Meteorological Office took possession of its war-time headquarters on the outskirts of Dunstable. The decision, that in the event of war the communications centre for the forecasting service should be established in a provincial location, had been made nearly two years earlier. The principal requirement from the communications aspect was that the site should be conveniently placed in relation to the main Post Office land lines. This requirement, in conjunction with other desiderata such as reasonably easy access from London, proximity to a town to facilitate the housing of personnel, and good wireless reception conditions, led to the selection in 1938, of a site on high land (about 500 ft. above sea level) just outside Dunstable.

At a later stage it was decided that, as a war time provision, the main forecasting centre should be at the same place as the communications centre. Dunstable was therefore planned as a combined forecasting and communications headquarters of the meteorological service. Plans were prepared and were being considered when in the summer of 1939 the threat of war became so imminent that immediate action was necessary. New plans based on the use of standard hutting were quickly prepared and building was begun.

A modern forecasting centre such as Dunstable was planned to be involves, however, a great deal more than the mere provision of roofs and walls, and much still remained to be done when war was declared at the end of August 1939. As a temporary measure, pending the completion of Dunstable, the Forecast Division was evacuated to offices already prepared at Birmingham. This emergency centre was occupied at three day's notice, without disturbing the flow of current synoptic information outstations.

The move to Dunstable was made under appalling weather conditions and was a complicated operation. A 24-hour service had to be maintained without interruption, so it was necessary to move the staff by stages, the last contingent travelling by car over roads deep in thawing snow. The change over of teleprinter lines was made between 1500 and 1600 on February 4, 1940. The 1500 reports were dealt with at Birmingham and the 1600 reports were dealt with at Dunstable. It was an outstanding feat in the history of the Post Office Engineering Department and was accomplished without a hitch.

The location of the evacuation centre (at Birmingham) had been kept secret, and it was known by the code name of ETA (the Greek letter η). By the time Dunstable was ready for occupation, everyone had become used to speaking of the provincial headquarters of the Forecast Service as "ETA" and the name was retained for the new station.

To explain the role of ETA in the forecasting organization it is necessary to describe briefly the arrangements which are in operation for supplying the Royal Air Force with weather reports and forecasts. The general principle is that every important airfield has its own Meteorological Office, which is responsible for the meteorological services needed by aircraft using that airfield. This means that there are a very large number of separate forecasting offices in all parts of the country, in each of which charts are drawn and forecasts are prepared. In general, the forecasting offices also act as weather reporting stations. The normal procedure is to furnish a coded report every hour and to plot a chart every 3 hours, based on observations at the "synoptic hours" 0000, 0300, 0600, 0900, 1200, 1500, 1800 and 2100 G.M.T.

The first obvious necessity for such a service is that there must be a highly efficient network of communications to collect the hourly reports and redistribute them to the forecasting centres, so that all of them may be continuously supplied with up-to-date information for the whole area. The second necessity is a system of co-ordination to ensure that the views as to the main developments of weather expressed by the forecaster at one station will not differ materially from those expressed by the forecaster at another station close by.

Fig. 1 is an attempt to set out the organization diagramatically. At each operational Group Headquarters there is a Type I Meteorological office which exercises a sort of parental control over a number of subsidiary offices of lower categories. The fundamental analyses and forecasts are originated at the Central Forecasting Office (C.F.O.) which thus furnishes guidance to all the forecasting offices in the system. There are also Type I offices at Command Headquarters, and these are responsible for the general co-ordination of the meteorological services within the Command. Fig. 1 is of course purely diagrammatic and highly simplified. The number of local forecasting offices represented by the small circles actually amounts to some hundreds.

The requirement of a rapid and efficient network of communications is met by the meteorological teleprinter system. The general lay-out of this system is represented

by the full lines in Fig. 1. Main lines radiate from C.F.O. to Group offices where they terminate on switchboards. The Group switchboards have connexions to all the stations controlled by the Group, which can thus be put into direct communication with C.F.O. whenever desired. In addition to the main lines to Groups and Commands, C.F.O. also has direct teleprinter lines to the British Air Forces Overseas Headquarters in Germany, the Headquarters of the American Forces in Europe, the Forecast Centres of the French, Belgian and Dutch Meteorological Services, Broadcasting House, the Central Telegraph Office, the Admiralty, etc. (see Fig. 2).

The system for collecting reports works in the following way. Each reporting station in a Group teleprints its coded message to the Group Headquarters where two teleprinters are available to receive them. The Group then compiles a collective message in standard form and teleprints it to C.F.O. At C.F.O. there is a separate teleprinter for each Group in the system, and there is, therefore, no delay in transmission. Connected to each of these teleprinters at C.F.O. there is a "reperforator" which produces a punched tape record of the message at the same time that it is received in typed form. By about 8 minutes past the hour practically all the hourly reports have been received in this way.

Punctually at 10 minutes past the hour the operator throws the switches on the main panel to the "send" position, and then passes the punched tapes through an automatic transmitter which broadcasts the messages at high speed to all stations. This main broadcast of British and near continental data is completed by the half hour. The remainder of the hour, until H 55 minutes, is occupied with broadcasts of foreign data upper air data, thunderstorm locations (SFERICS), ships' reports analyses and forecasts, and special reports of sudden changes. This main broadcast to all stations is supplemented by a second broadcast to Groups only.

The teleprinter room, though one of the most interesting features of C.F.O., represents only one side of the communications system. Parallel with the teleprinter room and almost equalling it size is the wireless reception room, manned by a civilian unit of the R.A.F. (No. 90 Group). Here are received practically all the meteorological transmissions of foreign data available for the northern hemisphere, as well as direct interceptions of reports from ships at sea and meteorological reconnaissance aircraft. Both rooms of course function continuously day and night. In the adjacent "auto room" transmissions are made continuously by radio channels to overseas and foreign services too distant to be connected to the teleprinter broadcast.

Mention must also be made of the AIRMET radiotelephony broadcasting system which is operated under the joint auspices of the Air Ministry and the Ministry of Civil Aviation. This service, which is the post-war successor to the "Borough Hill" broadcasts of pre-war days functions from 7 a.m. to 10 p.m. in summer, 6 p.m. in winter, and is intended primarily to serve the needs of flying clubs and private fliers using the smaller airfields. The hourly schedule includes navigational warnings, statements of the general weather situation and expected developments, reports of actual weather conditions from selected stations, and talks by the forecaster twice in every hour, in which the weather factors of importance for flying are dealt with in detail.

Dunstable also acts as the control station of the SFERIC service for the location of sources of atmospherics, within a range of 1,500 miles, using a radio direction-finding method. The results which are of great importance in relation to flying operations, and also as an aid to forecasting, are broadcast at frequent intervals on both the teleprinter and radio broadcasting systems.

In the forecast room surface charts covering most of Europe and the northern Atlantic are plotted every 3 hours and smaller scale charts are plotted every 6 hours (at main synoptic hours) for an area extending westward as far as the Pacific coast of North America, eastward to the Urals, northward to Spitzbergen and southward to north Africa. For the AIRMET service these are supplemented by large scale charts for the British Isles prepared hourly. Upper air contour charts are drawn every 6 hours for the 700, 500 and 300 mb. pressure levels. Full analyses for the main synoptic hours are made both for the surface and upper air distributions, and prognostic charts are prepared for periods of 24 hours ahead in the case of the surface charts, and 12 hours ahead in the case of the upper air charts. These analyses and prognoses together with detailed forecasts for aviation and technical appreciations of the situation are broadcast for the general guidance of outstations in preparing forecasts for local use.

The forecasts and warnings prepared at C.F.O. also include those broadcast by the B.B.C., forecasts for the Press, and a large number of special forecasts, warnings and notifications of specified conditions required by shipping, public services, industrial organizations, and members of the general public. The installations at C.F.O. include a printing plant operated by H.M. Stationery Office. Four large lithographic presses produce the Daily Weather Report which is now issued in three sections, the British Section (4 pages), the Upper Air Section (4 pages) and the International Section (2 pages of charts issued daily and 4 pages of data issued every four days). The lithographic transfers for these reports are prepared by draughtswomen in the forecast room. The C.F.O. printing plant also produces many of the blank plotting charts used in the synoptic service, instrumental charts and marine charts.

In this short account of C.F.O. it has not been possible to describe all its activities in full detail, but it is hoped to publish further articles in which special features such as the AIRMET broadcasting installation will be more adequately dealt with. The first of these, on SFERICS, follows immediately.

December 1947

FUNDAMENTAL PROBLEMS IN METEOROLOGY

Compiled by the Meteorological Research Committee

The Meteorological Research Committee has recently compiled a list of the problems which, in the view of members, are fundamental problems in the science of meteorology today. Some of these problems are suitable for attack by independent workers and steps have accordingly been taken to distribute the list to research workers in the Universities and University Colleges in this country. It is hoped that this action will stimulate interest in meteorological research.

The full list of problems is given below.

Dynamical or mathematical problems

1. Investigation of the formation, persistence and movement of anticyclones and wedges.

2. "Further outlooks" deduced from pressure distribution over northern hemisphere.

Mathematical examination is needed for these two problems in addition to the empirical study in the Meteorological Office.

3. Large scale air movements in the stratosphere and the extension of dynamical treatment to the stratosphere. The north or south movement of air in the stratosphere is of great scientific interest in meteorology.

4. Determination of the rate of travel of waves in the atmosphere.

5. Factors governing the travel of depressions.

6. Energy transformations in relation to the development of pressure systems.

7. Investigation of convergence and divergence and geostrophic departure of the wind.

8. Application of statistical methods to vector quantities.

9. Equations of motion. — (a) Solution of the equations allowing for the variation of the Coriolis force — extension of Grimes' solution[1]. See also classic paper by Guldberg and Möhn[2].

(b) Solution of equations for accelerated motion with constant uniform pressure field and its application to forecasting wind.

(c) Solution of equations for accelerated motion by expressing the pressure variation as exponential or circular functions (Fourier series) of the time.

(d) Investigation as to the reality of the oscillatory motion arising from geostrophic acceleration. See a paper by Hesselberg on atmospheric oscillations[3].

(e) The effect of friction; decay of atmospheric oscillations (see the paper by Hesselberg, in which it is assumed that the friction is proportional to the velocity); further investigation of the solution for unsteady motion and its extension to include initial departures from appropriate solution for steady state.

(f) Investigation of the effect of the movement of air across the isobars on the pressure distribution.

Physical problems

10. The distribution of temperature in the stratosphere.

11. Possible use of water-vapour content to identify air masses in the stratosphere.

12. Possible use of ozone content to identify air masses in the stratosphere.

13. Structure of fronts in the upper troposphere and stratosphere as indicated by temperature, humidity, ozone and winds.

14. Reliable climatological data for upper air from 0 to 24 Km. for each month and all possible parts of the world.

To include temperature, pressure (density), humidity, winds, height of tropopause and giving both average values and variations from day to day and year to year.

Much of this could be compiled now and is badly wanted. Data for less explored parts of the world and humidities of the upper air could be added as they become available. Some work is in hand in the Meteorological Office.

15. Radiation in the atmosphere. (As programme for Gassiot Committee)

(a) Measurement of absorption coefficient of atmospheric gases under atmospheric conditions.

(b) Theoretical discussion of absorption and radiation of heat by the atmosphere.

(c) Calculation of equilibrium temperature for an height, at any latitude and any season including diurnal variation of temperature.

(d) Rate at which air masses at different levels would acquire new temperature if transported to different latitudes.

(e) Measurement of water vapour at all heights, seasons and latitudes.

(f) Measurement of ozone at all heights, seasons and latitudes.

16. Physics of condensation and sublimation of water vapour in the atmosphere.

17. Formation of rain and snow from cloud.

18. Latent heat of vaporization of supercooled water. Apparently no data available.

19. Factors affecting coalescence of water drops having diameters in the range 1 μ to 7 mm. Affects development of fog, cloud and rain.

20. Factors affecting the change of state from supercooled water in droplet form to ice. Affects development of clouds and ice accretion on aircraft.

21. Nature of sublimation nuclei.

22. Radiation from small particles floating in the atmosphere and the consequential effects of the temperature of the particles being different from that of the ambient atmosphere. Effects of radiation on the lapse rate and stability in a cloud layer.

23. The transfer of air downwards by the drag of a falling raindrop. The mixing resulting from this process may affect the structure and composition of the lower atmosphere.

24. The fundamental theory of turbulence and its relation to the distribution of eddy velocities in space and time.

The theory of atmospheric diffusion and turbulence has been largely built up on R_ξ the correlation of the eddy velocity of the same particle at various intervals of time ξ. This correlation is not directly observable, nor of itself important. In view of the conditions of continuity and conservation of momentum and vorticity, it seems probable that some relation must exist between R_ξ and the correlation of wind at one point at various intervals of time and at one instant at various points in space. Knowledge of such relations would enable studies in diffusion to be directly linked with wind observations and studies of "bumpiness". It would also lead to an understanding of the diffusion of water vapour by eddies too large to be observed except in wind variations.

25. The balance between radiation, diffusion and turbulence in the lowest layers of the atmosphere.

(a) With reference to fog and dew.

(b) With reference to air flow from water surface to land surface and vice verse. Kew already have in hand the simultaneous investigation of the diffusion of heat, water vapour and momentum and the flux of radiation. Similar work is also in hand at Rye and Cambridge.

26. Physics of thunderstorms.

Forecasting problems

27. Investigation of factors which govern the formation and dispersal of low stratus cloud.

28. Relation between horizontal temperature gradient and large-scale instability. Treatment of thunderstorm development to include horizontal temperature gradient as well as vertical temperature gradient.

Instrumental problems

29. Development of a method of measuring air temperatures on high-speed (jet) aircraft which will avoid the application of large airspeed corrections.

30. Design of a new method of humidity measurement in radio-sondes at all heights.

31. Design of a relatively cheap instrument to measure atmospheric ozone.

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(1) GRIMES, A.; The movement of air across the Equator. *Mem. Malayan met.Serv.*, Singapore, No. 2, 1937.

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(3) HESSELBERG, TH.; Uber oszillatorische Bewungen der Luft. *Ann. Hydrogr., Berlin*, **43**, 1915, p. 311.

October 1949

WEATHER FORECASTS BY TELEVISION

By E.G. Bilham, B.Sc., D.I.C.

On the evening of July 29 television viewers in Great Britain were able to see and hear a new feature in the programme broadcast from Alexandra Palace, namely a weather report and forecast illustrated by charts. This feature has since been included as the last item of the television programme each evening.

The weather report begins with a brief summary of the weather of the day, illustrated by a chart (see Fig. 1, p. 314) headed "Weather this evening" showing in a very generalised sort of way the weather over the British Isles at 5 p.m.. This is followed after a brief pause by a second chart (Fig. 2), headed "Weather expected to-morrow morning", with spoken text indicating the main features of next day's weather over the country as a whole. Next follows a more detailed forecast for London and south-east England covering the period 8 a.m. to midnight. The report concludes with a "Further Outlook" for London and south-east England. The actual text of the spoken script which accompanied the charts on July 29 (the Friday preceding August Bank Holiday) was as follows:

Television Forecast, Friday, July 29, 1949

Here is the Meteorological Office weather report and forecast. The first chart shows the general weather situation this evening.

A north-westerly air stream covers the British Isles. Weather is fine generally apart from scattered showers in Scotland and northern England. It has been fine all day in the south-eastern districts of England, where temperature has exceeded 70 degrees. In northern and western districts there have been bright intervals and scattered showers.

By tomorrow morning the weather chart is expected to look like this.

It will be fine over the whole country in the morning, and the fine weather will last all day in most districts. Rain moving east from the Atlantic will reach Ireland and west Scotland during the afternoon or evening.

Here is the forecast for London and south-east England for tomorrow, 8 a.m. to midnight:—

Fair and rather warm, with afternoon temperature 75 degrees or slightly higher.

Finally here is the outlook for London and south-east England for Sunday and Monday.

Occasional rain on Sunday but perhaps only in small amounts. Bright intervals on Monday with a cool breeze. A chance of a few showers in the afternoon and evening.

The planning of this television feature gave rise to a number of problems. The first trials showed that it was quite impossible to televise successfully anything resembling an ordinary synoptic chart with the usual plotting of wind, weather and temperature. It was essential that the viewer should be able to take in, without effort, what he saw on the screen, and he could not be expected to memorise symbols or to strain his eyes by trying to read small lettering or figures. After several trials it became manifest that the sort of chart required was one in which the main weather features over relatively large areas were indicated by boldly printed legends without attempting to indicate small local variations. In the charts as now televised the weather legends are half-inch block lettering. Wind directions are shown by very bold arrows, and the strength of the wind is roughly indicated by using a long arrow for winds of Beaufort force 6 or more and a shorter arrow for force 5 or less. Isobars are shown at intervals of 4 mb. and italic lettering is used to indicate centres of high and low pressure. Land areas are distinguished from sea areas by tinting the former in a carefully selected shade of light grey.

For technical reasons black lines on a white background do not televise satisfactorily, and paper is unsuitable because it tends to bend and cockle under the heat of the illuminating lamps. The charts used are therefore specially printed on light grey cardboard. As a further example of the technical complications it may be mentioned that this short item, lasting, only two or three minutes, necessitates the use of three television cameras, one for the announcer and one for each of the two charts.

As an introduction to the series Dr. J.M. Stagg gave a short talk, illustrated with charts in which he explained the main weather features associated with high and low pressure systems, and how forecasting depends primarily on estimating the movements and developments of these systems.

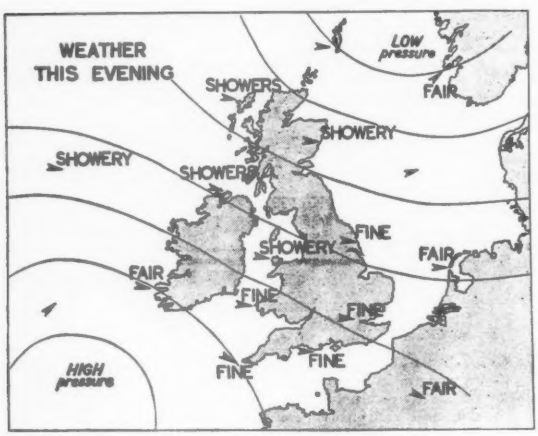


FIG. 1—FIRST CHART FRIDAY, JULY 29TH, 1949, 5 P.M.

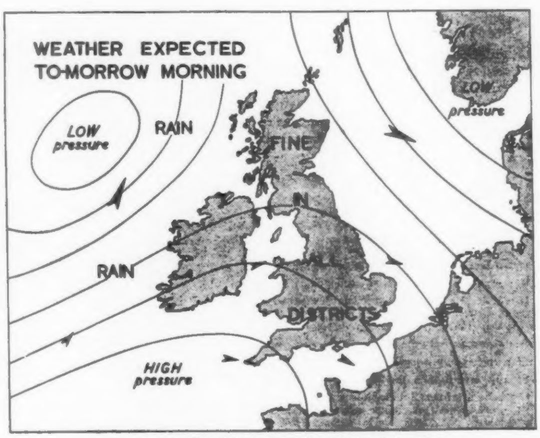


FIG. 2—SECOND CHART FRIDAY, JULY 29TH, 1949.

278

March 1954

WEATHER FORECASTS ON TELEVISION

By The Director of the Meteorological Office
(Dr O.G. Sutton F.R.S.)

On January 11, the B.B.C. began the transmission of a new type of weather news item in the regular television programmes. Previously the forecasts had been read by an unseen announcer during the display of two "still" charts. As many readers of the Meteorological Magazine are aware, in the new programmes a member of the Office staff appears in the studio every night and spends five minutes discussing the weather situation, past, present and future, with the aid of simplified isobaric charts.

The new series has barely completed a month's run at the time of writing so that it is far too early to attempt any serious evaluation of the techniques adopted, but it is safe to say that, judged by the reaction of the press, the "live" presentation is generally looked upon as a big improvement on the old "static" programme. To a certain extent the present period is regarded by the Meteorological Office and the B.B.C. as experimental, and it was recognized that the forecasters chosen for this exacting work would need a little time to accustom themselves to their new duties. Actually, the three meteorologists who have initiated the new series — T.H. Clifton, G. Cowling, and P. McAllen — seem have struck the right note from the start.

There is, of course, nothing essentially new in this use of television, and the weather talk has been accepted as an essential ingredient of television programmes in the United States and in Canada for some time. However, the British system differs from those in vogue across the Atlantic in several ways. In at least one widely distributed American programme the forecaster speaks from his office to the announcer in the studio who draws a simplified map according to the forecaster's instructions. In other programmes the forecasts are given by one selected "weather man". I believe that the present policy of bringing the forecasters to the studio and of using a team, instead of an individual, is the right choice for this country. The method of presentation, namely the "serial story" which starts by a brief recital of the successes and mishaps of yesterday's forecasts followed by a quick run-over of present weather as a lead-in to the prebaratic chart and the area forecasts, is one which will have to be judged by results over a long period. Before the programmes were put on the air, the B.B.C. and the Meteorological Office co-operated in a long series of experiments with various types of presentation, including animation, but there is no finality in the choice of the present method and suggestions for improvements would be welcomed.

I believe that the introduction of this direct "forecaster to public" service is an event of considerable significance for the Meteorological Office. The communication of the conclusions of the meteorologist to the user is at least as important as the preparation of the forecast, and in this connexion it must be realized that the general public needs special attention. I believe it is generally recognized by the specialist users that a forecast is a statement of probabilities, a warning that the physical conditions obtaining in the atmosphere at a given time may lead to certain eventualities, and the prudent professional user makes his plans accordingly. Meteorologists should try to get the same view adopted by the general public to a greater extent than at present. In the present state of our knowledge of atmospheric processes it is often not possible to go beyond admitting a risk of certain unpleasant forms of weather, such as thunderstorms, in certain areas, but the forecast is not necessarily valueless if these possibilities do not materialize. The meteorologist, in fact, should regard himself as much an adviser as a prophet. The direct broadcast, especially on television, allows this approach to be made more easily and more convincingly than does the written bulletin, which tends to give the impression of hedging if it contains too many expressions of uncertainty. It remains to be seen if the new venture will achieve success in promoting a better understanding of the work of the forecaster; that it will engender a more lively interest in meteorology can hardly be in doubt.

For these reasons, if no other, the advent of the television weather programme is to be welcomed, and the Meteorological Office is grateful to the British Broadcasting Corporation for the advice and assistance which have been given so freely in the preparation and maintenance of the new programme.

July 1954

CONFERENCE ON HIGH-SPEED COMPUTING

By the Director of the Meteorological Office

The Director of the Meteorological Office, Dr. O.G. Sutton, accepted an invitation to take part in a conference on the application of high-speed computing to problems of meteorology and oceanography, sponsored jointly by the University of California in Los Angeles and the National Science Foundation of America, on May 13, 14 and 15. The conference brought together some of the leading workers in this subject, and was marked throughout by brisk discussions.

The conference opened with a short statement by Dr. Sutton on the historical background of the meteorological problem, in which he traced briefly the development of mathematical methods in weather forecasting from the early "mechanical models" of Rayleigh, Shaw, Exner and others, to the polar-front analysis of Bjerknes, the courageous but deeply significant attempt of Richardson in 1922 to apply the equations of hydrodynamics to the problem, up to the present stage. Dr. Sutton emphasized his view that the present attack, while not involving the extreme generality of Richardson's approach, was not restricted to any closely defined models of atmospheric systems and therefore appeared more promising, although it must be recognized that the mathematicians had deliberately omitted certain factors, not because they are small, but because they are too complicated to be included at present.

Major P.D. Thompson (United States Air Force Geophysics Research Directorate) followed with an interesting paper on the integration of the equations of hydrodynamics for large-scale non-geostrophic motions. Major Thompson pointed out the importance of Charney's discovery that it is possible to exclude certain classes of unwanted solutions (those corresponding to sound waves and gravity waves) by the judicious use of the hydrostatic equation and the geostrophic balance, without seriously endangering the solutions corresponding to the large-scale disturbances in which the forecaster is most interested. He concluded, however, that, for good predictions of weather, it is necessary to introduce some type of non-geostrophic motion, and he outlined a possible procedure for doing this.

Dr. Jules Charney (Institute for Advanced Study, Princeton), one of the best known workers in numerical forecasting, then gave a lengthy and deeply interesting account of the whole subject and of the progress made so far at the Institute for Advanced Study. As much of this account dealt in detail with the mathematical basis, it is not possible to give an adequate summary of Dr. Charney's lecture here. He pointed out the necessity for including more than two levels in the work and illustrated his theme by showing the calculated pressure field for the famous "Thanksgiving Day storm" of 1950. This occasion is one which is not likely to be forgotten quickly by American meteorologists because of a depression which formed near the northern coast of the Gulf of Mexico, moved up the east coast from Florida, and deepened rapidly as it approached the densely populated areas near New York, finally producing a heavy snowstorm which completely ruined the national holiday in that part of the country. The official forecasters did not foresee this development and public faith in meteorology received a rude shock. Calculations with relatively simple models fail to show any such pronounced cyclogenesis, but with the 3-level model a good approximation to reality was achieved. There seems little doubt that if such a result had been available to the routine forecasters at the time, they would have been forced to reconsider their forecast before publication.

Dr. Charney gave some interesting facts about the effort involved in producing a 3-level 24-hr. forecast for the United States. The solution of the equations necessitates about a million multiplications and divisions, ten million additions and subtractions and some thirty million mathematical "orders" to the machine. These can be done in 45 min. with an existing machine and there is good hope that this period can be reduced to about 15 min. A 5-level model would require not more than three hours to solve the equations for a 24-hr. forecast, and a 3-level 5-day forecast would be completed (as far as the pressure field is concerned) in perhaps 20 hr. of machine time, but of course, the value of such a forecast is problematical. Dr. Charney also discussed the difficult problem of handling the initial data objectively and outlined a possible method of bringing this within the scope of the machine.

Dr. Sutton explained what is being done in the United Kingdom and showed slides comparing the machine forecast with the prebaratics made by Dunstable for the same occasions. The tendency noticed in the Sawyer–Bushby scheme to exaggerate the deepening of depressions or the building-up of anticyclones is not as evident in the American results. On the other hand, there seems to be no case yet examined at the Central Forecasting Office, Dunstable, in which the machine scores a spectacular success over the human forecaster, as in the case of the Thanksgiving Day storm.

Dr. J. Namias (United States Weather Bureau) gave an account of his researches into long-range forecasting and provoked a lively discussion on this subject. Prof. H.A. Panofsky (Pennsylvania State College) gave an

interesting talk on his investigations into the spectra of wind turbulence. Other speakers included Dr. H. Wexler (United States Weather Bureau), Prof. Syono (Japan), Dr. W.H. Munk (Scripps Institution of Oceanography) and Prof. J.J. Stoker (New York University). Between them they covered a wide field, ranging from tropical cyclones to tidal theory and river-flood prediction.

One of the high lights of the conference was a public lecture by Prof. J. von Neumann, who covered the whole field in his inimitable manner, quoting masses of figures and speaking without a pause for over an hour without (as far as the writer could see) a single note. Prof. von Neumann has a memory which rivals any electronic device yet devised.

The conference closed with a visit to the Scripps Institution of Oceanography at La Jolla, near the Mexican border, where the visitors experienced the far-famed Californian climate at its best.

The Director subsequently visited the astronomical observatory at Mount Wilson (including a discussion on turbulence in nebulae) and afterwards the United States Weather Bureau at Washington. Meteorologists will be interested to know that on July 1 it is proposed formally to institute in the United States a Joint Numerical Weather Prediction Unit, which will operate alongside WBAN (the joint aerological analysis unit). The staff, under the general direction of Dr. Wexler, will number about 32 in all, of whom at least half will be professional meteorologists, and the remainder mathematicians, programme experts, punch-card operators, etc. The machine, of advanced design, is expected to be delivered about October 1. Daily charts (and perhaps 2 per day) may be produced early in 1955 for comparison with actual charts, and it is hoped gradually to bring numerical forecasting into routine weather forecasting within the year.

This development will be watched with the greatest interest everywhere, and nowhere more than in the United Kingdom. If the scheme proves successful, 1955 may well mark one of the historic turning points of our science.

In conclusion, this was a highly interesting and successful conference, which brought many of the leading workers into contact with each other and succeeded in putting matters in proper perspective. For this one may thank the University of California in Los Angeles, and the National Science Foundation of America for their generous hospitality, and Dr. F. N. Frenkiel (Johns Hopkins University) in particular for his untiring and skilful administration of the conference.

June 1955 — Meteorological Office centenary issue

(This issue contained a wealth of interesting review articles, too long to reproduce here — especially as some of the source material has appeared on earlier pages. The following paper though is still topical! I have removed reference to the extensive bibliography quoted. Ed. (1994).

PRESENT POSITION OF THEORIES OF CLIMATIC CHANGE

By C.E.P. BROOKS, D.Sc.

In 1947 in an article in the *Meteorological Magazine* on the "Unsolved problem of climatic change" , five groups of theories were examined — variations of solar radiation, changes in the elements of the earth's orbit, movements of the continents, changes in the constitution of the atmosphere, and changes of configuration — but the conclusion was that all the theories so far advanced remained unproved. The seven years which have elapsed have, if anything, made confusion even greater. It may be of interest to take a brief glance at some of the recently published work and to assess the present position.

Variations of solar radiation, either alone or combined with some other cause are now first favourite. The theory which has been received with most interest is that of E.J. Öpik, first put forward in 1952 and completed in 1953, in which all changes of climate from major cycles of the order of 250 million years down to glacial and interglacial alternations are attributed solely to internal changes in the constitution of the sun. On the other hand, the theory of F. Hoyle and R.A. Lyttleton that variations of solar radiation are due to the passage of the sun through concentrations of inter-stellar matter, is still actively maintained by Hoyle and was supported by M. Krook in the volume on climatic change (reviewed in the *Meteorological Magazine* for November 1954) which also includes a discussion of Öpik's theory. Cycles of solar radiation with no ultimate cause assigned were also postulated by J. Wolbach in this volume. B.M. Rubashev combines cyclical variations of solar activity with variations in the speed of rotation of the earth. All these theories are at present almost entirely hypothetical, with little or no evidence to support them.

D.H. Menzel finds the cause of ice ages in clouds of ions reaching the earth from the sun and providing sublimation nuclei in the upper atmosphere, but he remarks that volcanic dust could adequately fulfil the same role.

Most writers adopt the view, which will certainly commend itself to meteorologists, that changes of solar radiation, especially in the ultra-violet, take effect through changes in the atmospheric circulation, but two opposing points of view still prevail. Thus H.C. Willett supports with modifications Sir George Simpson's view that glaciation could be attributed to increased solar radiation in selected wave-lengths acting through changes of circulation. His idea is that an increase of solar radiation would raise temperature in low latitudes more than in high latitudes, increasing the poleward transport of heat and water vapour and so causing more snow in the subarctic regions. In a later paper he summarizes a comprehensive review of the evidence as: quiet sun — interglacial; steady moderately disturbed sun (minor sun-spot maxima) — glacial; extreme solar disturbance (major sun-spot maxima) — chaotic climatic stress and deglaciation. On the other hand H. Flohn from a study of the circulation during the cold winters of 1939–42 attributes glaciation to a marked decrease of solar radiation, especially in the ultra-violet, resulting in a strengthened meridional circulation and weakened W. winds (low-index type).

Orogenesis and changes of land and sea distribution do not now appear to be accepted as the major cause of climatic changes, but several authors express the view that both solar and geographical changes are required for ice ages. R.F. Flint explains the glaciations of Alaska on these lines, with emphasis on the solar changes, while M. Schwarzbach places the emphasis rather on orogenesis, and B. Bell postulates high ground, a change of solar radiation and favourable topography, with possibly increased corpuscular radiation, to warm the polar stratosphere and so produce polar low-pressure areas.

Changes in the elements of the earth's orbit and the inclination of the axis are rather out of favour. They are still maintained by F.E. Zeuner and G. Bacsák, while D. Brouwer has produced a new solution, but they are rejected as insufficient by A.J.J. van Woerkom.

The third group, continental drift or pole shifts, also has a few adherents, among whom may be mentioned K.A. Pauly who adopts Sir Arthur Eddington's theory of a sliding of the earth's crust over the interior due to tidal friction, and J. Goguel who attributes displacements of the pole to winds, ocean currents and tides.

Changes in the constitution of the earth's atmosphere now reduce almost entirely to the effects of volcanic dust, H. Wexler having revived W.J. Humphreys's theory of the cooling effect of a volcanic-dust veil, while volcanic dust plays a subordinate role in several other theories. In a recent one by C.A. Zapffe volcanism in the Atlantic region plays a dual role, submarine eruptions causing a large supply of water vapour and aerial ones the necessary veil to lower temperatures generally, but Zapffe also brings in theosophy and destruction of Atlantis to buttress his case.

From this rapid survey it will be seen that the problem of climatic change is really little nearer to a solution than it was seven years ago. The theories current in 1947 are still being argued; even some old ones have been revived. Thus in 1950 E. le Danois brought back O. Pettersson's theory of climatic changes due to internal oceanic tides, and in 1952 H. Gerth revived C.E.P. Brooks's geographical theory of the Permo-Carboniferous glaciation. Perhaps the most hopeful sign is that in 1954 palaeoclimatologists are not quite so tied to single causes to the exclusion of all others as they seemed to be in 1947; it is becoming accepted that combinations of two or more causes are necessary to explain the facts. The most urgent need now is for some credible method direct or indirect, of reconstructing the variations of solar radiation during geological time; when that point has been cleared up the way may be open for the evaluation of other factors.

July 1955

Meteorological Office Staff Centenary Dinner

This was held on the evening of March 11 at the Holborn Restaurant and was attended by no less than 218 members, or former members, of the staff with their guests. Sir Graham Sutton acted as President and the company were graciously received by him and Lady Sutton.

After an excellent meal, reminiscent of pre-war standards, and the loyal toast to Her Majesty the Queen, Mr. H.L.B. Tarrant proposed the toast of the Meteorological Office, reminding his audience of the days when the staff numbered less than 40. In his reply, Sir Graham reminded his audience of some of the great names of the past and expressed his delight in seeing so many old members of the staff. He also paid tribute to the present staff for the way in which they carried on the great tradition of service, and said that he hoped in his term of office to see them brought closer together by the provision of a national weather building worthy of the name.

Before the toast of the Ladies, proposed in characteristic maritime vein by Cmdr Frankcom, each lady was presented with a thermos jug. In her reply, Lady Sutton looked forward to the day, already envisaged by Sir Graham, when, with the Headquarters establishments housed under one roof, social functions and activities of various kinds would be much easier to

arrange and to attend; and wives would get to know each other better.

In proposing the toast of the officers and members of the Social and Sports Committee, Dr. Stagg outlined its history, and referred to the successes achieved on the football field and in the athletic arena, the winning of the Air Ministry Challenge Cup and the Bishop Shield for 7 and 6 years in succession respectively. Mr. N.H. Smith, Chairman, replied, paying a tribute to the organizing genius of Mr. Ben. G. Brame (Treasurer) and Miss Joan Wordsworth (Secretary) which had done so much to ensure the success of the dinner. He also reminded his hearers of the sources of committee funds, and that, but for support from those funds it would have been impossible to meet the expenses of those representative football and athletic teams which, under the enthusiastic guidance of Mr. H.A. Scotney, had proved so successful in departmental competitions. He also called attention to a Centenary Souvenir in the shape of an attractive perpetual calendar which was now available to purchasers on application to the Secretary.

Amongst former members of the staff present were Sir David Brunt, Sir George Simpson, Mr. E. Gold, Mr. R.G.K. Lempfert, Mr. R. Corless and Mr. W. Heinemann — a veteran of 90 years.

It was generally agreed that the occasion has proved a delightful and memorable one, although there was regret that time did not permit, as was intended, of the mingling together of old colleagues and friends in an after-dinner conversazione.

November 1955

Thunderstorm at Sharjah on November 14 1954

A storm with unusual intensity of rainfall and lightning occurred at Sharjah, on the Oman Peninsula in the Persian Gulf, on the evening of November 14, 1954

It had been noted that the ring of small isolated cumulonimbus clouds which had persisted most of the afternoon on the horizon were beginning to develop further. When dusk approached lightning became visible over the mountains to the east. As this increased in frequency and intensity it could be seen that considerable vertical development was taking place. This seems to have had a trigger effect on cloud to the west, south and north and by 2000 local zone time Sharjah was surrounded by towering cumulonimbus. Just before the storm broke at 2045, lightning was so frequent and intense as to appear one continuous vivid light, sufficient to read the small print of a newspaper in comfort. Rain, moderate at first, soon became violent turning to hail at 2100. The hailstones were up to 1 in. in diameter some of them of a flattened shape. precipitation turned to rain at 2115 and stopped abruptly at 2130. In a period of 45 min. 56.0 mm. (2.21 in.) of rain fell. The barograph trace showed a rise of about 7 mb. followed by a fall of about 5 mb. in this period.

There is unfortunately no record of the strength of the wind in the squall which accompanied the storm, but considerable damage was done to barousti* roofs. The whole area is sand with impervious consolidated coral beneath. The camp was quickly flooded and low-lying areas were under 30 in. of water. Some damage was done to a brick building by subsidence. The lightning was described by many observers as frightening but seems to have done no damage.

A.C. THOMAS

[The average annual rainfall at Sharjah (25° 20′N. 55° 24′E)† is 117 mm. (4.61 in.) and the average number of days in a year on which rain falls is 7; 108 mm. (4.29 in.) has been recorded in 24 hr. in November. Hail is very rare in the area. - Ed., M.M. 1955].

* Of woven cane.

† See London, Meteorological Office. Weather in the Indian Ocean. Vol. II, Part 3, The Persian Gulf and Gulf of Oman, 1941.

April 1958

CHARLES ERNEST PELHAM BROOKS, I.S.O., D.Sc.

Dr. C.E.P. Brooks, an Editor of the *Meteorological Magazine* for some 22 years, died on December 14, 1957, at the age of 69, after being confined to his home at Ferring, Sussex, for a few months with heart trouble.

For 41 years Dr. Brooks worked full time in the Meteorological Office, retiring as Assistant Director in charge of the Climatological Division. Initially he was allocated to the Library, where his wide reading and remarkable memory made him of particular service to his colleagues and also enabled him to develop his main interest in World Climatology. Author of numerous papers he was awarded the Buchan Prize of the Royal Meteorological Society in 1931. His published books include: *The evolution of climate* (1925); *Climate through the ages* (1926, second edition 1948); *British floods and droughts* (1928) with Dr. J. Glasspoole; *Climate* (1929); *Climate in every-day life* (1950); *Handbook of statistical methods in meteorology* (1953) with Miss N. Carruthers; and *The English climate* (1954). He gained an international reputation, notably in the field of climatic change, and has left the results of his life work for the benefit of present and future generations.

Dr. Brooks put forward the theory that the dominant factors in producing climatic changes were geographical, including variations in the distribution of land and sea, systems of ocean currents, the vertical circulation of the sea, the elevation of the land and the amount of explosive volcanic activity. Along these lines he gave an explanation of the Permo-Carboniferous glaciation over low-lying areas in equatorial regions.

Dr. Brooks had the responsibility of moving the Library and the Climatological Records to Stonehouse, near Stroud, at the beginning of the war, and afterwards to Harrow. He had a reputation for swift action, but the sudden arrival of a large consignment of packing cases at the Office at South Kensington at the beginning of hostilities surprised even those familiar with his way of cutting through any red tape. He a did much to keep the staff happy, while in billets, and during the enforced long hours of work during the war. Then he had the responsibility of preparing climatological reports on various parts of the world, coping with many war-time climatological problems and also keeping together the corps of voluntary climatological and rainfall observers. Towards the end of the war he was directed to devote his full time to long-range forecasting, a problem in which he was especially interested. He did not spare himself, although this investigation did not produce the hoped-for results. Some indication of the scope of the work for which he was responsible is reflected by the various separate Branches which emerged under post-war conditions:— British Climatology, Rainfall of the British Isles and Hydrology, Agricultural Meteorology, Overseas Climatology, Upper Air Climatology, Library and Editing, and the Machine Pool using Hollerith cards for climatological data.

Dr. Brooks always had time to help and encourage his colleagues, and with his ready wit and understanding made even the most laborious extractions or computations of live interest to his staff. He set an example of energetic application to his work. He lived a full life, often claiming that he produced more useful work in his train journeys to and from Ferring than in the routine of Office administration. Following a short period of part-time employment at the Meteorological Office he found congenial work at home in abstracting meteorological literature for the American Meteorological Society, which later resulted in a visit to Washington.

Dr. Brooks' energies were not entirely confined to work. He started the Air Ministry Chess Club after the First World War and under his guidance the team moved steadily to the first division of the Civil Service Tournament. He was keen on swimming, lawn tennis, and on contract bridge.

Dr. Brooks was Secretary of the Royal Meteorological Society from 1928 to 1932 and later Vice-President. He served as the Meteorological Office representative of the International Meteorology Organization Commissions for Climatology, Hydrology, Agricultural Meteorology and Bibliography and Publications at Toronto in 1947.

Dr. Brooks married Miss Dora Buckeridge, whom he met at the Meteorological Office, and whose constant help he acknowledged in his books and papers. She survives him, as does also their son, and they have the sympathy of his wide circle of friends.

April 1960

HIGH ATMOSPHERE RESEARCH IN THE METEOROLOGICAL OFFICE

By the DIRECTOR-GENERAL *(Sir Graham Sutton C.B.E., F.R.S.)*

Meteorologists like to think that "the sky is the limit", but their upward ambitions, until recently, have been determined by the fact that balloons carrying instruments cannot ascend beyond about 50 kilometres. The position has changed in the last few years. The rate of development of the rocket as a geophysical tool has exceeded all expectations and artificial satellites are in orbit around the Earth. The old limits of accessibility no longer apply.

The Meteorological Office has kept well in the fore of high atmosphere research by means of the Meteorological Research Flight. This unique unit has added greatly to the stockpile of knowledge of the physical properties of the upper air and the structure of clouds. But aircraft capable of acting as flying laboratories are even more limited than balloons in the heights attained, and it has been evident for some time that meteorology must turn its attention to the rocket as a routine sounding device if the supply of data is to match the demands of the theoreticians.

It has therefore been decided to create within the Meteorological Office a new Assistant Directorate to deal with the problems of the high atmosphere. In meteorology the adjective "high" must be interpreted according to the facilities available at any given time. At the beginning of the century, when Teisserenc de Bort discovered the stratosphere, the "high atmosphere" extended only a few kilometres above the tropopause. Today, we may pause at about 100 kilometres, the level at which dissociation becomes significant and the stratosphere (if the name can still be used) merges into the ionosphere.

The decision to regard, for the time being, 100 kilometres as the "top" of the meteorologists' atmosphere does not, of course, imply that meteorology ceases at this level, but merely that this is a convenient height for the separation of techniques. In the mid-latitudes there is little change in mean temperature from the tropopause to about 20 kilometres, but above this height temperature increases to a maximum of about 20 °C at 50 kilometres, followed by a fall to a second minimum of about −80 °C at 80 kilometres, after which there is another rise. The lowest appreciable ionization in the atmosphere, the D-layer, lies between 70 and 90 kilometres, and the base of the all-important E-layer is between 100 and 120 kilometres. The E-region and above are regularly explored by radio waves, but the atmosphere between 30 and 100 kilometres is something of a no-man's-land, inaccessible to balloons except in its lowest 20 kilometres and too low for ionospheric techniques, except in its upper layers. This part of the atmosphere is of considerable interest to meteorologists if only for the reason that ozone reaches its maximum concentration between 20 and 40 kilometres. It is certain that regular measurements of wind, pressure, temperature, density and ozone concentration between 30 and 100 kilometres would be especially valuable in studies of the general circulation of the atmosphere.

In general terms the task of the new unit is to extend our knowledge of the movements, physical state and composition of the Earth's atmosphere up to about 100 kilometres. The measurements will be made by instruments carried by large balloons, rockets and, it is hoped, artificial satellites. The rocket work is planned on two main lines: (i) with "large" rockets, such as Skylark and, (ii) with specially designed "small" rockets capable of carrying an instrumented telemetering head to about 60 kilometres. In the field of satellite observations the Office has begun a design study for an experiment to determine the vertical distribution of atmospheric ozone by means of the solar spectrum in the ultraviolet and visible ozone bands at satellite sunrise and sunset. The same instruments will probably allow determination of the total ozone content over the sunlit Earth by examination of the albedo in the same absorption bands. It is planned to complete this instrument in time for its inclusion in the second United States–British "Scout" satellite.

The problems of instrumentation involved in this work are both difficult and fascinating, but observations are but means to an end. In the planning of the staff, provision has been made for theoretical studies of the data obtained both in this country and abroad, as they become available.

Although the creation of the new unit involves many novel concepts, in another sense it is simply a logical continuation of the exploration of the atmosphere which began with kites and the Dines balloon-meteorograph and received its greatest impetus to date with the development of the radiosonde and radar-wind equipment. To the vast majority of meteorologists, rockets and satellites are unknown tools, but their potentiality is evident. It is to be hoped that the coming generation of meteorologists will discover in their results as great an inspiration and as valuable an aid towards the understanding of the ways of the atmosphere as our generation found in the radio-sonde and radar-wind soundings.

December 1960

NOTES AND NEWS

Adoption of the Celsius scale of temperature within the Meteorological Office

It has been decided to adopt from 1 January 1961 the Celsius scale of temperature for all temperature measurements, including "surface" observations, made for internal use within the Meteorological Office and for international purposes. Most readers will know that the Celsius scale has been used in the Office since 1 January 1956 for upper air observations.

The decision to change to degrees Celsius follows from a Resolution of Third Congress (1959) of the World Meteorological Organization expressing, amongst other things, the hope that Members who do not use the Celsius scale would adopt it for use in coded messages before Fourth Congress meets in 1964. For the Office to have gone over to the Celsius scale only in international synoptic reports would have involved unacceptable extra work, loss of time and risk of error in recutting teleprinter tape at the Central Forecasting Office for the international transmissions.

Thus all synoptic reporting stations controlled by the Meteorological Office including the auxiliary reporting stations will transmit temperature observations in degrees Celsius from 1 January 1961. The voluntary climatological stations will continue to use the Fahrenheit scale. Temperatures will be published in the Celsius scale in both the *Daily* and *Monthly Weather Reports*. The *Daily Aerological Record* has, of course, used that scale since 1 January 1956.

There will be no change in the temperature scales used for forecasts and weather reports for the public which will continue to use the scale with which the recipient is most familiar. Thus the forecasts for the general public, broadcast by sound radio and television and published in the Press, will continue to state temperature in degrees Fahrenheit while those issued for aviation will naturally continue to use degrees Celsius.

Detailed instructions have of course been issued to all those whose work is affected by the change.

Definition of "ground frost"

Since 1906 "ground frost" has been recorded by meteorological observers when the thermometer on the grass has fallen to or below 30 °F (30.4 °F for thermometers read to tenths). The reason for the introduction of the practice in 1906 has not been found, despite extensive search. The first publication of a reason appeared in the second (1930) edition of the *Meteorological glossary* where it is stated that injury to the tissues of growing plants is not caused until the temperature has fallen appreciably below the freezing-point of water.

The introduction of the Celsius scale of temperature into Meteorological Office practice for all internal purposes has led to a reconsideration of the definition of "ground frost". It has been decided that the explanation given in the Meteorological glossary, supposing it is correct, does not justify the continued use of the definition because the occurrence of "ground frost" is of importance to a larger proportion of the community, for example, in connexion with motor transport, than it was over fifty years ago. Therefore it has been decided that the practice of attaching special significance to the attainment of a grass minimum temperature of 30 °F (or 30.4 °F) or below by terming these "ground frosts" should no longer be continued.

Hence, on and after 1 January 1961, grass minimum temperatures will continue to be collected as hitherto. However, in publications the term "ground frost" will no longer be used and present statistics such as "Number of days with ground frost" will be replaced by "Number of days with grass minimum temperature 0 °C or below". On the other hand, it will be convenient to retain the term "ground frost" for use in forecasts, and when so used it will imply a grass minimum temperature at or below 0 °C (or 32 °F).

December 1960

HEADQUARTERS RE-ORGANIZATION

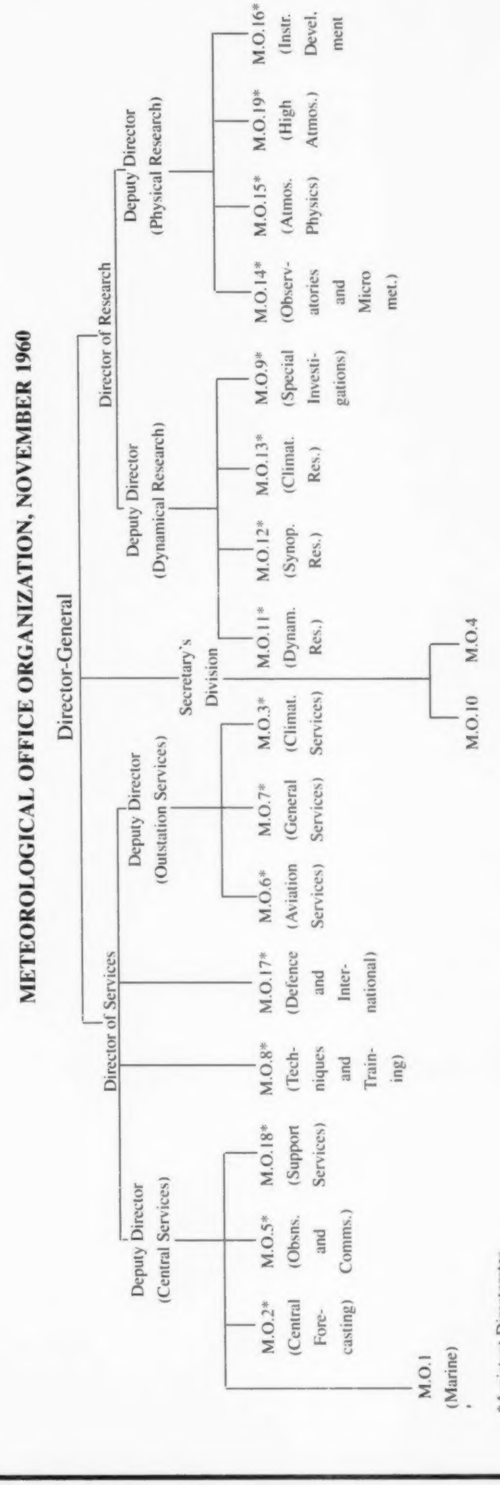
By The DIRECTOR-GENERAL *(Sir Graham Sutton C.B.E.,F.R.S)*

In 1957, as a result of the report of the Brabazon Committee, the structure of the directorate of the Meteorological Office was considerably changed. In 1961 the Headquarters sections of the Office, which for many years have been dispersed between London, Dunstable and Harrow, will come together at Bracknell. This has given an opportunity to reconsider the Headquarters organization in the light of experience gained in the last three years and the changes that are taking place in meteorology both as a science and a profession.

The outstanding feature of the Brabazon reorganization was the recognition of the dual role of the Office, namely, to provide meteorological services on a national scale and to act as the primary scientific institution of this country for the advancement of the science of the atmosphere, by the creation of two Directorates, of Services and Research, respectively. This fundamental division of responsibility has been maintained in the new structure. The Director of Research, Dr. R.C. Sutcliffe, F.R.S., has now become the senior Director and Dr. A.C. Best has succeeded Dr. Stagg as Director of Services.

This change necessarily means that the Director of Research, as deputy to the Director-General, has additional administrative and general policy responsibilities. A new deputy-director post has therefore been introduced into the research directorate. Mr. J.S. Sawyer has relinquished his personal post of Chief Forecasting Research Officer to become Deputy Director in charge of Dynamical Research. Other changes within the Research Directorate are that in future all public inquiries relating to areas outside the United Kingdom will be handled by Climatological Services (M.O.3), and the library and the editing sections will no longer be attached to Climatological Research (M.O.13), which, however, will absorb the long-range forecasting research unit from Synoptic Research (M.O.12). The last-named change reflects the view that long-range forecasting is more intimately related to the general circulation of the atmosphere than to ordinary synoptic meteorology.

The changes in the Directorate of Services reflect two features which have become prominent since the meetings of Lord Brabazon's Committee. In recent years there has been a continuing growth in demands for services not specifically related to aviation, and also something of a revolution in the handling and processing of the vast amount of information reaching the meteorological services. To meet the first situation, the administration of both civil and military meteorological services is now combined under one Assistant Director and, to reduce the load to manageable dimensions,



international work connected with civil aviation meteorology has been transferred to the Assistant Director in charge of Defence and International matters (M.O.17) who already handles relations with the World Meteorological Organization. In future this Assistant Director will report to the Director of Services, but he will continue to assist the Director-General when the latter acts as the United Kingdom Permanent Representative with the World Meteorological Organization or in his personal capacity as a member of the Executive Committee of the World Meteorological Organization.

A new post, that of Assistant Director (General Services) will cover all non-aviation matters outside climatology. The major interests of this assistant directorate will lie in the agricultural services and in the Weather Information Centres, of which three are now in existence, in London, Glasgow and Manchester. The Assistant Director (Climatological Services) takes over all climatological inquiries, including world climatology (as noted above) and marine climatology. The Marine Superintendent will concentrate upon the management of the Ocean Weather Fleet, the collection of data from ships, control of the Port Meteorological Officers, editing of the *Marine Observer* and the preparation of those of the publications of the Office that deal with the oceans. He and his Nautical Officer staff will act as advisers to the whole Office on problems calling for a seaman's professional knowledge of maritime matters.

The problems of data handling and processing have now grown so large and are so specialized that it has been thought advisable to create a new Assistant Directorate, called Support Services, to deal with these and other cognate matters, including the Library, Archives and all editorial and cartographical work for official publications. It is clear that in the near future the collection, analysis and storage of meteorological data must become part of an integrated system depending more than ever on machines. The problem of specifying such a system has been under intensive study in the Office for some time.

The new organization is shown in the diagram. The reunion of parts of the Office that have been separated geographically for so many years has made possible a closer integration and a more rational division of duties. It cannot be too strongly emphasized that the Meteorological Office is a single entity dedicated to the task of advancing the science of the atmosphere in both its pure and applied aspects. The new arrangement, it is hoped, will enable it to function efficiently and harmoniously in its new home.

January 1966

Press Conference

The Director-General held a Press Conference at Bracknell on 2 November, 1965 to mark the introduction of routine numerical forecasts in the Meteorological Office. The Conference was attended by a wide cross-section of the national and technical Press, the BBC, and a large corps of photographers.

An introductory talk by the Director-General was followed by 45 minutes of lively questioning. The Press were then invited to watch the production of the first routine chart on the line printer, each correspondent receiving a souvenir copy. There followed visits to the Central Forecasting Office and informal discussions with senior members of the staff.

The Conference was reported on radio and television, produced leading articles in *The Times* and the *Financial Times* and was extensively reported in the national and local Press. The substance of the Director-General's talk is given below:

Ladies and gentlemen, it gives me great pleasure to welcome such a large and distinguished gathering of the Press to the Meteorological Office. Today is a landmark in the history of forecasting in the Office — a history which goes back more than a century — because this afternoon you will see the production of our first routine numerical weather forecast by the computer. But first I should like to introduce some of my colleagues who are involved in this important project, and then take a few minutes to explain how the machine forecast is produced, its significance, its limitations, and something of our plans and hopes for the future.

As many of you will know, the traditional techniques of weather analysis and forecasting involve the preparation, at regular three- or six-hour intervals, of maps that give a two-dimensional representation of weather conditions at the earth's surface and at a number of levels in the upper air. Observations of pressure, temperature, humidity, wind and so on, made simultaneously at fixed hours at hundreds of stations all over the world are transmitted as quickly as possible to all countries on an internationally agreed basis. When these data are plotted on the maps the forecaster draws lines (for example isobars connecting places recording the same pressure and isotherms connecting places at the same temperature) which emerge as recognizable patterns that reveal the position, structure and evolution of weather systems. After careful study of these patterns in relation to similar charts for earlier times, the forecaster can extrapolate for some hours ahead the tracks of the main depressions and anticyclones and the movements of such features as troughs, ridges, fronts and rain areas. Here the forecaster relies upon a number of well-tested rules, his understanding of the physical processes, his experience of how similar situations have developed in the past, and his intuitive feeling for how the atmosphere works. This judicious combination of

knowledge, experience, intuition, judgement and flair introduces a subjective element into the forecast. Nevertheless, even under the difficult conditions experienced in the British Isles, the main features of the daily forecast are correct on about 85 per cent of occasions; not unnaturally the public tends to remember only the mistakes which, by the way, are usually errors of timing.

But over the years it has become apparent that the traditional techniques have been pushed nearly as far as seems profitable; at any rate there is no real hope of further major improvements. The objective is, of course, more comprehensive, detailed and accurate forecasts that will remain reliable for longer periods ahead. Among other things, this will require many more observational data from larger regions of the atmosphere. Now clearly there is a limit to the quantity of data that a human forecaster can assemble, assimilate, analyse and interpret in the short time allowed by the fact that he has to keep well ahead of the actual weather. This is where the big computers come to the rescue. They are able to handle huge quantities of data and perform vast numbers of mathematical calculations at very high speed. For example, our KDF9 computer, named COMET, can make an addition or subtraction in one millionth of a second. We have, of course, to tell it exactly what to do and how to do it.

I shall now try to explain, in simple terms, the procedure for making a numerical forecast. We work with a large section of the atmosphere stretching from Hawaii to Malaya, from the North Pole to central Africa, and extending up to a height of about 40,000 feet, and we concentrate on developments at three levels — at the surface, at 20,000 and at 40,000 feet. We subdivide this huge region by a grid, similar to lines of latitude and longitude, that provides 1300 regularly-spaced grid points. Fed with weather observations made simultaneously from 1200 land stations, 300 ships, and 600 radiosounding balloons that transmit information on pressure, temperature, humidity and wind up to heights of 100,000 feet, the computer assigns a value for the pressure and temperature at each grid point at a convenient 'zero' hour. We also supply the computer with a very simplified mathematical description of the atmosphere — a set of differential equations to describe the gross behaviour of the air in our region and to allow the machine to compute how the pressure and temperature will change at each grid point during the next hour. (In practice it is more convenient to work in terms of two parameters called contour heights and thickness patterns, but these are closely related to pressure and temperature.) Using these new values the computer then carries the calculation forward in steps of one hour until, eventually, we have a forecast, for 12 or 24 hours ahead, of the distribution of pressure and temperature at the three levels. In addition, the machine calculates the large-scale vertical motions of the air which indicate regions of widespread cloud and rain and of dry settled weather. The whole operation takes less than one and a half hours.

Here I must emphasize that, because we are using only a very simplified model of the real atmosphere, the computer at present calculates only the gross features of the pressure and temperature field — the position and movement of the large weather systems such as the depressions and anticyclones. It does not attempt to deal with the detailed weather such as the occurrence of showers, thunderstorms and fog; these are added by conventional methods. Some progress along these lines is possible, at least in principle, but you will appreciate the magnitude of the problem when I tell you that one of our current research investigations on the development of a simple pair of fronts taxes the largest computer available in this country.

We show here a series of computed charts forecasting the conditions at midnight tonight; for comparison we also show the corresponding charts drawn by the human forecaster. I think that you will agree that, as far as the positions and magnitudes of the main pressure centres are concerned, the correspondence is very good. Such agreement is fairly typical in that, during the research trials, the computed forecasts of surface conditions were, on average, about as good as those produced by an experienced forecaster, while the computed upper air charts were consistently a little better. This degree of reliability in the numerical prognosis of the large-scale pressure field, essential to the production of a good weather forecast, is most encouraging. So, from today, the computed charts will serve as an additional aid to the forecaster. For a time he will continue to draw his conventional maps and use the machine forecast as a strong second opinion, but we hope and expect that, within a few months, he will acquire sufficient confidence in the computed charts to accept them unchanged. Since the machine actually prints the predicted values of pressure and temperature at each of the grid points on the chart, and will shortly be drawing the isopleths automatically, the forecaster may look forward to being relieved of much donkey work and to having more time for analysis and interpretation of his data and for presentation of his forecast to the customer.

Looking into the future, to more accurate forecasts for three, four or more days ahead, we shall need a number of things: a deeper understanding of how the atmosphere works on a global scale; a more sophisticated mathematical description of the atmosphere; many more observational data, particularly from the oceans and tropical regions and, perhaps, from the southern hemisphere; faster methods of communication to transmit these data; and bigger and faster computers. Given all of these and satellites too, we may look forward to gradual rather than dramatic improvements in the quality and range of the weather forecast. The atmosphere is an infinitely complex, subtle machine that will tax not only the largest computers, but more important, the best of our physicists and mathematicians for many years to come. Therein lies the challenge.

March 1977

THE METEOROLOGICAL MAGAZINE 1866–1977

The *Meteorological Magazine* has, in one form or another, been published for more than 111 years and we thought that our readers, particularly the new ones, would be interested in a brief history of how the Magazine came into being of its subsequent management and organization, including an account of the various editors. The Magazine, as the official journal of the Meteorological Office dates only from February 1920 and is really an amalgamation of *Symons's Meteorological Magazine* (published by the old voluntary British Rainfall Organization) and the official Meteorological Office Circular.

Symons's Meteorological Magazine

This magazine began its life in February 1866 as *Symons's Monthly Meteorological Magazine*, the monthly publication of the British Rainfall Organization, and hence owes its existence to that remarkable man George James Symons, F.R.S.. Mill (1938) has given a succinct account of Symons's life, of how he resigned in 1863 from the Meteorological Department of the Board of Trade (later to become the Meteorological Office) in exasperation at the attitude of official superiors, and of his immense achievement in creating the British Rainfall organization virtually single-handed. Although the Magazine was started primarily to inform and unify Symons's army of co-operating voluntary rainfall observers, and was an improvement on his 'Rainfall Circulars' of the previous few years, almost from the first it carried short articles and notes on a wide variety of climatological and meteorological phenomena very much as the monthly magazine *Weather* (published by the Royal Meteorological Society) does today.

For a number of years before the end of the century Symons was helped in the task of running the British Rainfall Organization — which included editing the annual British Rainfall as well as the monthly Magazine — by H. Sowerby Wallis. Symons died in 1900 and on 1 January 1901 Hugh Robert Mill, D.Sc., LL.D., was appointed joint-director of the Organization with Wallis. Mill edited the Magazine until his early retirement — due to ill-health — in 1919; his life and work are well described by Glasspoole (1950) and Carter (1951). Following Mill's appointment the word 'monthly' was dropped from the title of the Magazine.

Mill's eyesight had given him trouble since 1913, and an increasing share of responsibility for the Organization and its publications was taken by Martyn de Carle Sowerby Salter who became joint-director and joint-editor. Mill's retirement in 1919 coincided with the taking over of the British Rainfall Organization by the Meteorological Office, of which it became a Division with Carle Salter — as he was generally known — as its Superintendent. The last issue of *Symons's Meteorological Magazine* was for January 1920.

The Meteorological Office Circular

On 20 June 1916 the Meteorological Office began the publication of a leaflet called the 'Meteorological Office Circular' principally for distribution among observers. This provided a convenient means for the publication of Official notices, changes in observing staff, brief reviews of recent publications and other matters of general meteorological interest. The first four numbers were edited by R. Corless, and the remainder by F.J.W. Whipple. The last issue was dated 2 February 1920.

The Meteorological Magazine

The Meteorological Magazine was first published in February 1920, with a cover which in addition to line-portraits of FitzRoy, Symons, Sabine and Strachey bore the words: THE METEOROLOGICAL MAGAZINE, *Symons's Meteorological Magazine Incorporating the Meteorological Office Circular*. (This design of cover was used until January 1937, the last issue of Volume 72.)

The Magazine was edited jointly by Carle Salter and F.J.W. Whipple who was Superintendent of the Climatological Division. An editorial in the last issue of the old Symons's Magazine stated 'Whilst becoming, as a matter of course the organ of the combined meteorological services, the Magazine will, it is hoped, fully maintain its traditional character as a channel of communication between amateur meteorologists'; it is probably true to say that this hope was largely realized during the following twenty years.

In 1923 Carle Salter died at the tragically early age of 43 (see Mill (1923)), and Whipple was transferred to the British Rainfall Organization Division, becoming sole editor. In 1925 a reorganization of Meteorological Office structure took place, involving the setting up of Divisions of General Climatology and British Climatology with the British Rainfall Organization being attached to the latter. The Division of General Climatology was put under the charge of C.E.P. Brooks who was promoted to the grade of Superintendent; his job included supervision of the Meteorological Office Library, the study of world climatology and the Editorship of the *Meteorological Magazine*.

Brooks continued to edit the Magazine for 22 years including the period of second World War, although after June 1940 the need to conserve manpower led to the suspension of general publication in printed form and it was only a typescript edition — albeit with diagrams and photographs — that maintained a limited internal circulation. Proper publication was resumed with the

issue for January 1947, the wartime break having given the editor an opportunity to begin his next volume with that month and not February, a mildly irritating practice that had continued ever since February 1866. In the late summer of 1947 Brooks was succeeded as Editor by G.A. Bull who was later to become Assistant Director (Support Services).

After the war, a change of policy in the editing became apparent. Before 1940, the Magazine contained short general articles on meteorology and climatology, with accounts of remarkable weather events, Meteorological Office news, accounts of personalities including retirements, obituaries, promotions and special appointments, and correspondence from members of the Office and amateurs; there was little or no mathematics and nothing that could really be described as a scientific paper suitable for a learned journal. After 1947 an increasing number of papers appeared describing the results of original investigations carried out in official time.

By the time that Bull was succeeded as Editor by R.F. Zobel in November 1960, the Magazine had largely assumed its present appearance and character, though minor changes of content and cover design still occurred from time to time. Zobel was replaced in April 1962 by A.H. Gordon who was in his turn succeeded in March 1963 by W.S. Garriock.

Garriock proved to be another long-standing editor who spent nine years maintaining the high standards of accuracy and sub-editing which had rightly become characteristic of a Magazine that acted as the official organ of an old-established Government scientific department; he retired in June 1972. Between June 1972 and September 1974 the post of editor was filled successively by F.E. Lumb, J.G. Cottis, and J.B. Andrews; the present editor is R.P.W. Lewis.

After the above was written, Lewis was in post until 1986; then in rapid succession came R.W. Riddaway, B.R. May, F.E. Underdown and myself, R.M. Blackall

REFERENCES omitted from the original printing, but added later:

CARTER, H.E.	1951	*Brit Rainf*, 1949, pp.1–2.
GLASSPOOLE, J.G.	1950	*Met Mag*, **79**, pp. 180–182.
MILL, H.R.	1923	*Met Mag*, **58**, pp. 97–99.
	1938	*Met Mag*, **73**, pp. 165–168.

August 1979

Brief historical note on the formulation of Buys Ballot's Law

The name of Buys Ballot is to be found in almost every textbook of meteorology and his law of the relation of wind direction and pressure distribution is taught in the many schools which nowadays include elementary meteorology in their curriculum. It may therefore be of some interest to trace briefly the formulation of this law. Professor Buys Ballot, Director of the Dutch Meteorological Institute and Professor of Physics at Utrecht was amongst the pioneers in the use of synoptic meteorology for the issue of forecasts and storm warnings. In dealing with observations of pressure and temperature he made use of deviations from average values and in a paper presented to the Paris Academy of Sciences in 1857* he discussed the results obtained from observations at three stations in Holland. After showing that strong winds are indicated by large differences between the deviations, he proceeded to explain that if pressure was higher at Den Helder than at Maastricht (that is to say, higher in the north than in the south) then the wind was from the east while if pressure was higher at Maastricht the wind was from west or north-west. In the *Jaarboek* of the Meteorological Institute of the Netherlands for the same year (published in 1858) p. 347, this conclusion is stated in more general terms. Translated into English it reads 'great barometric differences, within the limits of our country, are followed by stronger winds, and the wind is in general perpendicular, or nearly so, to the direction of the greatest barometric slope in such a way that a decrease of pressure from north to south is followed by an east wind, and a decrease from south to north by a west wind'. In 1860 he published a paper entitled 'Eenige regelen voor aanstaande weersveranderingen in Nederland' (Some rules for approaching changes in the weather in the Netherlands), in which the law appears in its well-known form (pp. 50ff). 'Thus the rule for wind direction is this: if one places oneself in the direction of the wind with one's back to the place from which it is coming, then one has the lowest place (i.e. pressure) on the left-hand just as in the case of hurricanes'. (These storms had long been known to have a whirling motion and the distinction between the anti-clockwise rotation in the northern hemisphere and the clockwise rotation in the southern hemisphere had been expounded by Dove in 1828.)

[The above text, authorship unknown, is to be found in a pamphlet held in the National Meteorological Library and dated 1930.]

*Note sur le rapport de l'intensité et de la direction du vent avec les écarts simultanés du baromètre. *CR Acad Sci, Paris*, **45**, 1857, 765–768.

A remarkable rainstorm in Hong Kong

It is with much pleasure that I am able to close this final issue with a report of a rainfall event which would have been missed if the issue had been on time! Readers will probably be aware that heavy rain is not unknown in south-east Asia; see the January 1993 issue of The Meteorological Magazine. *However, press reports of 1000 mm in less than two days seemed to be stretching credibility, so I wrote to Mr Lam asking for confirmation. This is the reply I got.*

Dear Mr. Blackall,

Mr. C.Y. Lam asked me to provide you with some rainfall data recorded at Tai Mo Shan area during the heavy rainfall on 22–24 July 1994.

Tai Mo Shan is the highest peak in Hong Kong with a height of 957 metres. The rainfall recorder is a 0.5 mm tipping-bucket type and data are telemetered to a central station in the Geotechnical Engineering Office of the Civil Engineering Department in the urban area through leased telephone line and modems. Tai Mo Shan is one of the 48 automatic rain-gauges in the network. The data are also relayed to the Royal Observatory. The rain-gauge at Tai Mo Shan was checked to be functioning properly a few days before the occurrence of this heavy rain.

I have copied on the attached sheet some daily, hourly and 5-minute rainfall data recorded at this station that you may find interesting. I also enclose a copy of our *Monthly Weather Summary* for July 1994, which has just been published, for your background information on this rainfall occasion.

The 30-year (1961–90) normal rainfall distribution in Hong Kong indicates the maximum area is at Tai Mo Shan with an annual amount of over 3200 mm against 2214 mm at the Royal Observatory.

I hope the above information is useful for your magazine. Please let me know if you need any further material.

Yours sincerely
K.P. Wong
for Director of the Royal Observatory

Selected 5-minute rainfall (mm) recorded at Tai Mo Shan on 22 July 1994

Hour minute	01	02	05	06	07	09	10
00–05	4.0	15.5	7.0	1.5	15.0	4.0	38.5
05–10	2.0	11.5	2.5	1.5	12.5	2.5	30.0
10–15	2.5	8.5	10.5	3.0	11.0	9.0	35.0
15–20	1.5	6.5	10.5	3.0	12.0	3.5	28.5
20–25	2.5	7.5	8.5	2.5	10.5	3.0	14.5
25–30	4.0	5.0	5.0	1.0	2.5	2.0	12.5
30–35	1.0	4.5	1.5	2.5	5.0	2.5	9.0
35–40	3.0	2.0	1.5	2.0	3.0	4.5	4.5
40–45	4.0	3.5	2.0	5.0	1.5	4.5	5.5
45–50	14.5	4.0	1.0	6.5	0.0	6.5	3.5
50–55	18.0	4.0	1.5	6.0	0.5	3.5	2.0
55–60	21.5	4.0	1.5	11.0	0.0	23.5	2.0
Hourly total	78.5	76.5	53.0	45.5	73.5	69.0	185.5

Hourly rainfall (mm) recorded at Tai Mo Shan

Hour	22 July	23 July
01	49.0	29.5
02	78.5	41.0
03	76.5	34.0
04	53.5	39.0
05	52.5	36.5
06	53.0	13.5
07	45.5	9.5
08	73.5	2.0
09	21.0	3.5
10	69.0	6.0
11	185.5	3.5
12	15.0	1.5
13	15.5	1.5
14	15.0	1.0
15	27.0	0.0
16	12.0	0.0
17	4.5	1.5
18	0.0	0.5
19	1.5	0.5
20	0.5	23.0
21	4.5	14.5
22	3.0	10.5
23	4.0	2.0
24	15.5	0.0
Daily total	875.5	274.5

Daily rainfall (mm) recorded at Tai Mo Shan

21 July	22 July	23 July	24 July
136.5	875.5	274.5	109.0

The publication of the *Meteorological Magazine* will cease with the issue for December 1993.

The December 1993 issue of the *Meteorological Magazine* will be a bumper one of about 40 pages celebrating the Magazine's contribution to the development and dissemination of meteorological knowledge. It will contain a selection of highlights from 1866 up to around 1986.

As one of the leading European establishments for research into meteorology, our publications should be subject to external peer review: this is already the case for much Meteorological Office work. The publication of a new international and European quarterly journal by the Royal Meteorological Society (called *Meteorological Applications*) provides a suitable vehicle for most kinds of articles that have appeared in *Meteorological Magazine*, namely on research, practice, measurements, review articles, applications of meteorology, book reviews, etc. Enquiries should be addressed directly to the Royal Meteorological Society. Non-members should write to:

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The United Kingdom Meteorological Office (UKMO) Annual Scientific and Technical Review 1993/94

This Review describes the major developments in science and technology within the UKMO over the year April 1993 to March 1993 and is produced as part of the Meteorological Office Annual Report and became available in July 1994. If you wish to by put on the mailing list for future years please write to:

The News Desk, Publications (room 707a), Meteorological Office, London Road, Bracknell, Berks RG12 2SZ.

Back numbers

Limited stocks of back numbers from 1970 to date are available from:
Vic Silk, The Library, Meteorological Office, London Road, Bracknell, Berks RG12 2SZ; telephone 01344 854074. Copies cost £1.50 each (inclusive). Please send sterling cheques made out to 'Public sub-account HMG 4712'; leave the amount blank but cross them and endorse with the maximum so that the transaction can be made even if some of the requested issues sell out. Please send an addressed label with the order. Remaining stocks will be disposed of in March 1995.

Full-size reprints of Vols 1–75 (1866–1940) are available from Johnson Reprint Co. Ltd., 24–28 Oval Road, London NW1 7DX.

Complete volumes of *Meteorological Magazine* commencing with volume 54 are available on microfilm from University Microfilms International, 18 Bedford Row, London WC1R 4EJ. Information on microfiche issues is available from Kraus Microfiche, Rte 100, Milwood, NY 10546, USA.

LE MET MAG VA CESSER DE PARAITRE

C'est là une bien triste nouvelle: en 1994 *The Meteorological Magazine*, revue de vulgarisation et d'information générale du UK Met. Office, ne sera plus au rendez-vous chaque mois, pour des raisons apparemment 'politiques'. Il est probaible que la mission de vulgarisation et de service public que remplissait fort bien ce célèbre magazine a dû être estimée non 'rentable' (les guillemets pour signifier que ce vocable mériterait dans ce cas précis d'être explicité en termes d'intéret général, de connaissances pour le grand public, de culture et de civilisation dont l'apport ne peut être évidemment quantifié par les économists).

Qu'il nous soit permis ici de rendre hommage à *The Meteorological Magazine* et à tous ceux qui ont servi la météorologie grâce à ses colonnes depuis 1866, et en particulier à M. Rodney Blackall, son actuel rédacteur en chef.

La Météorologie December 1993 p.105

December 1993

Vol. 122
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Contents

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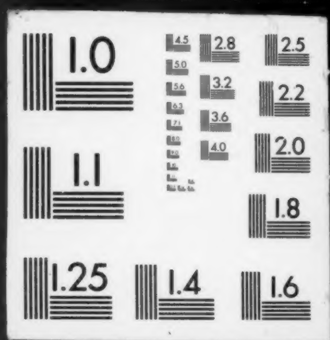
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